

**UNIVERSITY OF WATERLOO  
SENATE GRADUATE & RESEARCH COUNCIL  
NOTICE OF MEETING**

DATE: Monday 13 May 2019  
TIME: 10:30 a.m. – 12:00 noon  
PLACE: Needles Hall, Room 3318

Chair – C. Dean

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**AGENDA**

<u>Item</u>	<u>Action</u>
1. Declarations of Conflict of Interest a. Excerpt from Bylaw 1, section 8*	Information
2. Minutes of 8 April 2019* and Business Arising	Decision (SGRC)
3. Co-chairs' Remarks	Information
4. Academic Program Reviews a. <a href="#">Status of Reports under Review</a> b. Guiding Questions for Final Assessment Reports and Two-Year Progress Reports* c. Two-Year Progress Report – Pure Math Program* (David McKinnon) (reviewed by: Bergen)	Information Information Decision (SGRC)
5. Research Centres and Institutes a. Renewal: Water Institute* (Roy Brouwer) b. Renewal: Waterloo Institute for Sustainable Energy* (Jatin Nathwani) c. Renewal: Centre for Advanced Trenchless Technologies* (Mark Knight)	Decision(SGRC) Decision(SGRC) Decision(SGRC)
6. Curricular Submissions a. Applied Health Sciences*  b. Engineering* c. Mathematics*	Decision (SGRC) 2.1; SEN-Regular Decision (SGRC) Decision (SGRC)
7. Graduate Studies and Postdoctoral Affairs – Academic Calendar Changes	SEN-Regular
8. Graduate Awards* (O'Neill) a. Dean of Mathematics Excellence Scholarship – operating b. Science Graduate Award (SGA) – operating c. School of Pharmacy Annual Graduate Awards – operating d. Master of Environment and Business Award – operating e. Bruce Mitchell Graduate Scholarship – endowment f. Marie Curie Graduate Student Award – operating	Decision (SGRC) Decision (SGRC) Information Information Information Information
9. Other Business	Information
10. Next Meeting: 10 June 2019 from 10:30 a.m. - 12 noon; NH 3318	Information

\*material attached

\*\* to be distributed separately

“SGRC” to be approved on behalf of Senate

“SEN” to be recommended to Senate for approval

7 May 2019

Kathy Winter, PhD, CPsych  
Assistant University Secretary

# Excerpt from Senate Bylaw 1

## 8. Declarations of conflict of interest

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8.01	<p>At the beginning of each meeting of Senate or any of Senate's committees or councils, the chair will call for members to declare any conflicts of interest with regard to any agenda item. For agenda items to be discussed in closed session, the chair will call for declarations of conflict of interest at the beginning of the closed portion of the meeting. Members may nonetheless declare conflicts at any time during a meeting.</p>
8.02	<p>A member shall be considered to have an actual, perceived or potential conflict of interest, when the opportunity exists for the member to use <b>confidential information gained as a member of Senate, or any of Senate's committees or councils</b>, for the personal profit or advantage of any person, or use the authority, knowledge or influence of the Senate, or a committee or council thereof, to further her/his personal, familial or corporate interests or the interests of an employee of the university with whom the member has a marital, familial or sexual relationship.</p>
8.03	<p>Members who declare conflicts of interest shall not enter into debate nor vote upon the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).</p>
8.04	<p>Where Senate or a committee or council of Senate is of the opinion that a conflict of interest exists that has not been declared, the body may declare by a resolution carried by two-thirds of its members present at the meeting that a conflict of interest exists and a member thus found to be in conflict shall not enter into debate on the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).</p>

**University of Waterloo**  
**SENATE GRADUATE & RESEARCH COUNCIL**  
**Minutes of the 8 April 2019 Meeting**  
**[in agenda order]**

**Present:** Jeremy Bergen, Jeff Casello, Victoria Chu, Amelia Clarke, David Clausi, Bernard Duncker, Ana Ferrer, Rhona Hanning, Bruce Hellinga, Lauren Meliss Holst, Christiane Lemieux, Daniel Martel, Alexander Mercado, Kristen Müller, Daniela O’Neill, Jack Rehder, Simron Singh, Richard Staines, Mike Szarka, Shirley Tang, Shawn Wettig, Elise Lepage (on behalf of Linda Warley), Kathy Winter (secretary)

**Resources:** Trevor Clews, Jennifer Kieffer, Carrie MacKinnon, Amanda McKenzie, Alyssa Voigt

**Guests:** David Edwards, Stephanie L Luis, Sushanta Mitra, Lisa Pokrajac

**Regrets:** Raouf Boutaba\*, Charmaine Dean\*, Julie Joza, Bruce Muirhead\*, Max Salman, Naima Samuel\*, Takin Tadayon

**Organization of Meeting:** Jeff Casello, co-chair of the council, took the chair, and Kathy Winter acted as secretary. The secretary advised that due notice of the meeting had been given, a quorum was present, and the meeting was properly constituted.

**DECLARATIONS OF CONFLICT OF INTEREST**

No conflicts of interest were declared.

**CONSENT AGENDA**

Council heard a motion to approve or receive for information the items of the consent agenda. Hanning and Hellinga, Carried.

**1. MINUTES OF 18 MARCH 2019**

Council approved the minutes of the meeting.

**2. UNIVERSITY RESEARCH**

Council received updates, as presented, for information.

**3. GRADUATE AWARDS**

Council approved items (a) through (d), as presented.

**4. ACADEMIC PROGRAM REVIEWS**

Council received the update for information.

**REGULAR AGENDA**

**5. BUSINESS ARISING FROM THE MINUTES**

There was no business arising.

**6. CO-CHAIRS’ REMARKS**

Casello reported: 55 NSERC doctoral awards (increase of 6 over last year); 3 Vanier awards & 3 alternates. Ranking process to be reviewed to ensure alignment with Vanier attributes of interest.

**7. RESEARCH CENTRES AND INSTITUTES**

**a. Renewal: Waterloo Institute for Nanotechnology.** Council heard a motion to approve the 5-year renewal of the Waterloo Institute for Nanotechnology (WIN), as presented. Sushanta Mitra (executive director) and Lisa Pokrajac (assistant director) overviewed this, largest in Canada, interdisciplinary research hub for nanotechnology. In discussion: Clausi highlighted (referencing page 125-126 of agenda package) that faculty of engineering only supported a 2-year renewal given concerns re: budget, WIN mandate, Nano at Waterloo in relation to Nano within WIN. Duncker stated that same was raised at Research Leaders Council—with vote ultimately being “in favour”

for 5-year (vs 2-year) renewal thereby allowing for a more fulsome strategic planning cycle (there was one vote against). Council heard an amended motion to approve the 2-year renewal of WIN. Clausi and Hellinga. Opposed with 1 in favour. The original motion to approve the 5-year renewal of WIN (Clarke and Wettig) was carried with two opposed.

**b. Renewal: South Western Ontario Research Data Centre.** Council heard a motion to approve the 5-year renewal of the South Western Ontario Research Data Centre, as presented. Stéphanie Llus (centre director) described size, composition, funding of this faculty-level centre. Post-meeting, Llus provides [SWORDC's April newsletter](#) subscription link for dissemination to those interested. Ferrer and Hanning. Carried.

**c. Dissolution: Centre for Applied Cryptographic Research.** Council heard a motion to recommend to Senate the dissolution of the Centre for Applied Cryptographic Research (CACR) in 2019, as presented. Duncker and Clausi. Carried.

## 8. NEW PROGRAM

Council heard a motion to recommend to Senate the approval of a new Master of Pharmacy (MPharm) in Advanced Pharmacy Practice to be offered by the School of Pharmacy, effective 1 September 2019, as presented. David Edwards (Associate Dean, faculty of science) provides rationale: There is need for advanced pharmacist practitioner with expert knowledge to manage complex patients or complex drug therapy in specialized patient populations. This requires higher level of knowledge and skill. As pharmacy education evolved in North America, a modified version of the original PharmD has become the entry-to-practice degree for pharmacists and post-baccalaureate PharmD programs have been discontinued. The combined effect of the discontinuation of post-baccalaureate PharmD programs and the lack of residency training opportunities in Canada is a shortage of pharmacists with advanced clinical and research skills needed to meet the needs of health care institutions and universities for clinical practitioners, educators and scientists. The proposed Master of Pharmacy program is designed to address this need. In discussion: size of initial cohort (6); few additional resources expected to be needed; use of external partners to deliver programming; confirmation that proposed tuition is aligned with other similar course-based Master's programming; schedule being supportive of existing professional career. Two minor editorial changes were made at Attachment #1: IAP updated table on page 27 of 27; removal of reference to 200 MB of data storage on page 21 of 27. Wettig and O'Neill. Carried.

## 9. CURRICULAR SUBMISSIONS

**a. Arts.** Council heard an omnibus motion to approve items a through e as presented. As a discrepancy was noted between role of departmental chair in the examination process in Arts (chair as voting member) and GSPA (chair as non-voting member) this motion was tabled—pending further clarification of any Arts' exception. This motion (with amendments shown at Attachment #2) later came forward to council by e-vote (18 April 2019 - 23 April 2019). O'Neill and Rehder. Carried with one abstention.

Council heard a motion to recommend to Senate item f, as presented. Lepage and Ferrer. Carried. Council heard a motion to approve item g and h, as presented. Lepage and Ferrer. Carried – noting that the check box denoting course as “new” was not checked (page 269 of agenda package).

**b. Engineering.** Council heard a motion to recommend to Senate to approve item 3i and 3j as presented. This involves, within the MEng in Electrical and Computer Engineering Program the addition of Graduate Specializations in place of the currently offered graduate diplomas: (1) Graduate Diploma (GDip) in Computer Networking and Security and (2) Graduate Diploma (GDip) in Sustainable Energy. Specializations to be added:

- computer networking and security, as well as sustainable energy, effective 1 September 2019
- nanoelectronic circuits and systems, as well as artificial intelligence and machine learning, effective 1 January 2020.

Hellinga and Lemieux. Carried.

Council heard a motion to approve, as presented:

- item 1 (Hellinga and Wettig. Carried recognizing correction of minor omission as noted at Attachment #3)
- item 2 (Hellinga and Wettig. Carried)
- item 3a-3h (Hellinga and Lemieux. Carried)
- item 4 (Hellinga and Wettig. Carried)
- item 5 and item 6, effective 1 May 2019 (Hellinga and Duncker. Carried)

**c. Environment.** Council heard a motion to approve, as presented and effective 1 May 2019:

- item 1 (Singh and Hanning. Carried – noting a typo under 1a – page 390; Wilfrid Laurier)
- item 2 (Singh and Clarke. Carried)

**d. Mathematics.** Council heard a motion to approve, as presented:

- item 1 (Lemieux and Martel. Carried – noting friendly amendment of 1 May 2019 effective date)
- item 2.1-2.1.2 (Lemieux and Martel. Carried)
- item 2.2-2.4 (Lemieux and Wettig. Carried)

**e. Science.** Council heard a motion to approve, as presented:

- item 1 (Wettig and Ferrer. Carried – noting friendly amendment under 1a - page 441 of agenda package at Attachment #4)
- item 2,4 (Wettig and Bergen. Carried)

Council heard a motion to recommend to Senate to approve the revision to the Fields of Study for the PhD and MSc in Earth Sciences programs, effective 1 May 2019 (friendly amendment), as presented. Wettig and Bergen. Carried.

## 10. GRADUATE STUDIES ACADEMIC CALENDAR CHANGES

Council heard a motion to recommend to Senate to approve Graduate Studies Academic Calendar changes, effective 1 May 2019, as presented:

- Graduate Student Progress. Casello described how Guidelines for evaluating and providing feedback on graduate student progress in PhD and research Master's programs and coursework programs have been developed to provide better clarity of expectations for students and faculty.
- Number of terms a student can be inactive for parental leave: Changing the number of terms a student can be inactive for parental leave to match the federal government legislation of 18 months (this falls between 4 to 5 terms). The Graduate Operations Committee agreed to allow 5 terms for parental leave.
- Full-time student definition: Expanding the full-time student definition to include information from the Ontario Council on Graduate Studies, 2017, "Principles for Graduate Study at Ontario's Universities, Resolution 5 - The principle on timely completion". Clarification that 10 hour rule pertains to work internal to the university.

Müller and Hellinga. Carried.

On behalf of Senate, council approved Graduate Studies Academic Calendar changes, effective 1 May 2019, as presented:

- Student records ownership and access
- Editorial updates

Müller and Hellinga. Carried – with friendly amendment to ensure gender neutral language (their).

## 11. OTHER BUSINESS

There was no other business.

**12. NEXT MEETING**

The next meeting will be on Monday 13 May 2019 from 10:30 a.m. to 12 noon in NH 3318.

2 May 2019

Kathy Winter, PhD, CPsych,  
Assistant University Secretary

# **UNIVERSITY OF WATERLOO**

## **GRADUATE PROGRAM PROPOSAL OF**

## **MASTER OF PHARMACY IN ADVANCED PHARMACY PRACTICE**

**Submitted to the  
Ontario Universities Council on Quality Assurance**

### **VOLUME I - PROPOSED BRIEF**

JANUARY 2019

staff, as well as select Internet resources freely available to anyone. The Library has purchased, or subscribes to, research databases, full text journals, monographs, numeric data, and government publications. The electronic collection includes over 55,000 e-journals in a wide range of disciplines along with more than 640 e-journals that are classified as Pharmacy and Pharmacology. These resources will be sufficient to meet the needs of MPharm program.

The School has its own Learning Resource Centre which occupies ~ 2,000 square feet of space on the lower level of the pharmacy building with 24/7 access for faculty, staff, and students. The Liaison Librarian for Pharmacy (Caitlin Carter, MLIS) is the primary individual responsible for supporting the information needs of faculty and graduate students associated with the School of Pharmacy. Searching and retrieval of scientific information is a critical skill for graduate students and the librarian is available to provide formal instruction or informal consultation to assist graduate students with improving their capabilities in this area. The Liaison Librarian for Pharmacy develops information literacy-related activities and materials, in consultation with faculty. These include the development of online modules, research guides and screencasts as well as the seminars and outcomes-based workshops for students in the program.

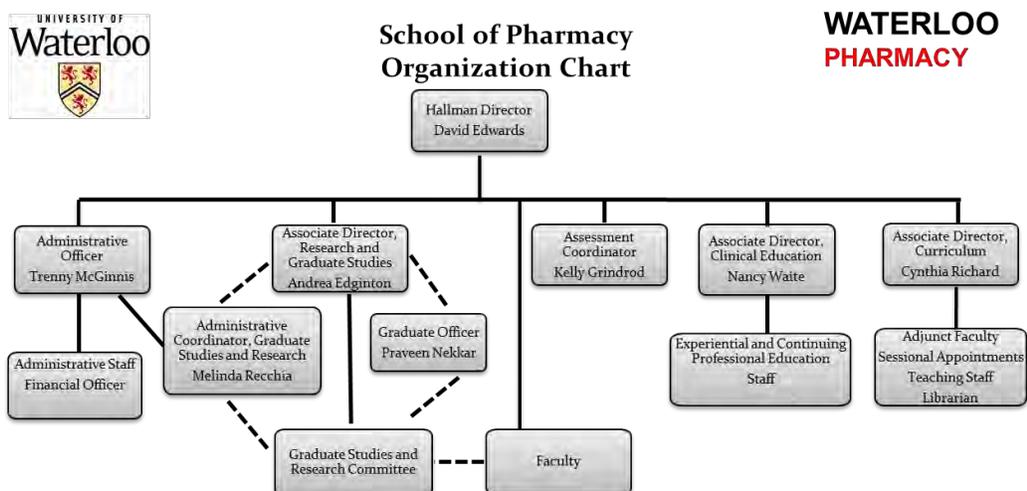
### **3.2 Laboratory Resources**

The School of Pharmacy has approximately 7,500 square feet of wet laboratory research space, primarily on the 3<sup>rd</sup> and 4<sup>th</sup> floor of the building, along with an animal holding facility on the main level to support animal research. In addition, there is an extensive suite of core equipment to support basic research. Students in the MPharm program will primarily be engaged in clinical or applied research that will involve data collection at the clinical site or the use of previously collected health information available within various administrative databases. However, there may be some projects that will take advantage of the equipment and wet laboratory resources available at the School of Pharmacy.

### **3.3 Computer Facilities**

All faculty and graduate students are provided with an account on the Faculty of Science file server with **ample** storage. Wireless internet access is available throughout the Pharmacy building. Software packages, sold at discounted prices through educational software licenses, are available through the Campus Tech Shop.

The School of Pharmacy has recently completed construction of a Health Services and Applied Research Laboratory on the Lower Level to support clinical and applied research. The data centre occupies 2,300 square feet on the Lower Level of the building and significantly expands the capacity for clinical and applied research that requires intensive data analysis. This facility contains 18 work stations along with a



## 5. PROJECTED ENROLMENT

Enrolment projections are based on an anticipated maximum intake of 6 full-time students and 3 part-time students when the program reaches full capacity in Year 5. Further increases in student enrollment may be considered if there is sufficient student demand and the School of Pharmacy has sufficient capacity for placement in clinical rotation sites and supervision of research projects.

Projected Student Intake and Enrolments for the Master of Pharmacy in Advanced Pharmacy Practice (MPharm) Program					
YEAR	FULL-TIME		PART-TIME		TOTAL
	Intake	Enrolments	Intake	Enrolments	
2019/20	4	4			4
2020/21	6	10			10
2021/22	6	12			12
2022/23	6	12	2	2	14
2023/24	6	12	3	5	17
2024/25	6	12	3	6	18
2025/26	6	12	3	6	18

## 6. FINANCIAL PLAN

A financial plan was approved by the Provost on March 15, 2018.

# ARTS GRADUATE STUDIES

18 April 2019

TO: Members, Senate Graduate and Research Council

FROM: Rita Cherkewski, Administrative Coordinator, Arts Graduate Studies & Research

RE: Faculty of Arts Motion from 8 April 2019 SGRC to be approved by E-vote

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The Faculty of Arts would like to request approval via an e-vote for items A-E, and I noting the proposed amendment for item I.

“To be consistent with the new University-level PhD Comprehensive Examination minimum requirements the Faculty of Arts would like to amend item 9.a.l) PhD Comprehensive Revisions - Program Revisions: Accounting, Economics, English, French Studies, German, Global Governance, Religious Studies, Sociology.

Current content: **"Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee."**

Amended content: **"Who Chairs an examination: Consistent with University-level minimum requirements ~~with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee.~~"**

Rita A. Cherkewski, BA (Hons.), MA  
Administrative Coordinator, Graduate Studies and Research  
Faculty of Arts  
519-888-4567 ext. 33637, PAS 2428  
rita.cherkewski@uwaterloo.ca  
uwaterloo.ca/arts/

**ARTS FACULTY COUNCIL REPORT TO  
SENATE GRADUATE AND RESEARCH COUNCIL**

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**CURRICULAR ITEMS for approval [bottom right pagination]**

- A) Economics** - New milestones: PhD, PhD – Water, Qualifying Exam and Thesis Proposal [1-2]
- B) Economics** – Milestones inactivations: PhD, PhD – Water, PhD Comprehensive Exam I & II [3-4]
- C) English** – New Milestone: PhD Comprehensive Examination [5]
- D) English** – Milestone inactivation: PhD Field Examination [6]
- E) French** – New Milestone: PhD, Thesis Proposal [7]
- F) Political Science** – Program revision: MA & MA, Coop, removal of research fields [8-12]
- G) Political Science** – New courses: *PSCI 656 - The Politics of Inequality & PSCI 692 - Ecological Political Economy: Canada in Comparative Perspective* [13-14]
- H) Psychology** – New courses: *PSYCH 825A: Applied Practicum in Developmental Science I & 825B: Applied Practicum in Developmental Science II, PSYCH 826A: Research Practicum in Developmental Science I & PSYCH 826B: Research Practicum in Developmental Science I, PSYCH 827A: Applied Practicum in Industrial/Organizational Psychology I & PSYCH 827B: Applied Practicum in Industrial/Organizational Psychology II, PSYCH 828A: Applied Practicum in Social Psychology I & PSYCH 828B: Applied Practicum in Social Psychology II, PSYCH 829A: Research Practicum in Social Psychology I & PSYCH 829B: Research Practicum in Social Psychology II* [15-34]
- I) PhD Comprehensive Revisions** – Program Revisions: Accounting, Economics, English, French Studies, German, Global Governance, Religious Studies, Sociology [35-57]

**NB:** items F,G, and H are not subject to this e-vote as those items approved at 8 April 2019 Senate Graduate and Research Council

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts

**Program:** Doctor of Philosophy (PhD) in Accounting

**Program contact name(s):** Changling Chen, Jenny Rothwell

**Form completed by:**

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/school-accounting-and-finance/doctor-philosophy-phd-accounting>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>○ Upon satisfactory completion of course work (no failures, 78% average) students will write a comprehensive examination measuring knowledge in the chosen core discipline, functional area and methods specialty. <del>The Graduate Officer will form an Examinations Committee. This committee will set the comprehensive examination and recommend pass/fail to the Graduate Officer. The Graduate Officer must approve the comprehensive examination before it is taken and the pass/fail status before</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts Comprehensive Examination minimum requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements.</u></li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><del>the students learn of the results.</del> The written examination component of the comprehensive examination will have two requirements:</p> <ul style="list-style-type: none"> <li>▪ Specialist - to measure whether the student has the necessary foundation, methodological knowledge and skills to conduct research in the chosen methods specialty.</li> <li>▪ Breadth - to measure understanding of the various research questions and methods used in accounting research. A specialist level of knowledge will not be expected in research issues outside the student's selected core discipline, functional area and methods specialty.</li> </ul>	<ul style="list-style-type: none"> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Graduate Chair can approve the committee for comprehensive examinations.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul> <p>○ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in Accounting program are also required to meet the following requirements:</u></p> <ul style="list-style-type: none"> <li>▪ Upon satisfactory completion of coursework (no failures, 78% average) students will write a comprehensive examination measuring knowledge in the chosen core discipline, functional area and methods specialty. The written examination component of the comprehensive examination will have two requirements: <ul style="list-style-type: none"> <li>▪ Specialist - to measure whether the student has the necessary foundation, methodological knowledge and skills to conduct research in the chosen methods specialty.</li> <li>▪ Breadth - to measure understanding of the various research questions and methods used in accounting research. A specialist level of knowledge will</li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	not be expected in research issues outside the student's selected core discipline, functional area and methods specialty.

**How will students currently registered in the program be impacted by these changes?**

*Under the university comprehensive examination requirements, doctoral students (including the SAF accounting doctoral students) are not able to defer writing the comprehensive exam beyond the 7th term of their study.*

*Section will expand to accommodate content. Please include details here.*

**Departmental approval date** (mm/dd/yy): 01/25/19 (at SAF School meeting)

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 02/01/19

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts

**Program:** Doctor of Philosophy (PhD) in English

**Program contact name(s):** Marcel O’Gorman, Tina Davidson

**Form completed by:** Marcel O’Gorman, Tina Davidson

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/department-english-language-and-literature/doctor-philosophy-phd-english>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>● <del>PhD Field Examination</del> <ul style="list-style-type: none"> <li>○ <del>At the end of their course work and preliminary to registering for dissertation credit, candidates are required to sit 3 examinations, 2 written and 1 oral. The written examinations will be each be based on one area in each of the prescribed literary and language areas.</del></li> <li>○ <del>Candidates declare when registering to sit the first exam, which is their primary area of expertise and which their secondary.</del></li> <li>○ <del>The oral examination, which normally runs between 90 minutes to two hours,</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>● <b><u>PhD Comprehensive Examination</u></b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts Comprehensive Examination minimum requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with</u></li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>is based on the reading list and the written responses in the candidate's exam in the primary area of expertise.</p> <ul style="list-style-type: none"> <li>○ Literary Areas: <ul style="list-style-type: none"> <li>▪ American Literature</li> <li>▪ Canadian Literature</li> <li>▪ History of Literary Theory and Criticism</li> <li>▪ Middle English Literature</li> <li>▪ Nineteenth-Century British Literature</li> <li>▪ Postcolonial Literature</li> <li>▪ Renaissance English Literature (16th-17th centuries)</li> <li>▪ Restoration and Eighteenth-Century English Literature</li> <li>▪ Twentieth-Century United Kingdom and Ireland Literature</li> </ul> </li> <li>○ Language Areas: <ul style="list-style-type: none"> <li>▪ Composition Theory and Pedagogy</li> <li>▪ Discourse and Text Analysis</li> <li>▪ New Media</li> <li>▪ Rhetorical Theory and Criticism</li> </ul> </li> </ul>	<p><u>University-level minimum requirements.</u></p> <ul style="list-style-type: none"> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Graduate Chair can approve the committee for comprehensive examinations.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul> <ul style="list-style-type: none"> <li>○ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in English program are also required to meet the following requirements:</u></li> <li>○ <u>At the end of their coursework and preliminary to writing the dissertation, candidates are required to sit three examinations: two written and one oral. One written examination will be drawn from the Literary area and one from the Language area. Normally this will occur in year two.</u></li> <li>○ <u>The first written examination will comprise the candidate's Secondary field, and the second written examination will comprise the candidate's Primary field. The Primary exam will be followed by an oral defence of Primary examination questions and Primary reading lists.</u></li> <li>○ <u>Each written exam will be based on a core A-List of readings and a supplemental B-List of readings to be composed by the candidate and their committee.</u></li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<ul style="list-style-type: none"> <li>○ <u>The written examinations will be administered online in a take-home format.</u></li> <li>○ Literary Areas: <ul style="list-style-type: none"> <li>▪ American Literature</li> <li>▪ Canadian Literature</li> <li>▪ History of Literary Theory and Criticism</li> <li>▪ Middle English Literature</li> <li>▪ Nineteenth-Century British Literature</li> <li>▪ Postcolonial Literature</li> <li>▪ Renaissance English Literature (16th-17th centuries)</li> <li>▪ Restoration and Eighteenth-Century English Literature</li> <li>▪ Twentieth-Century United Kingdom and Ireland Literature</li> </ul> </li> <li>○ Language Areas: <ul style="list-style-type: none"> <li>▪ Composition Theory and Pedagogy</li> <li>▪ Discourse and Text Analysis</li> <li>▪ New Media</li> <li>▪ Rhetorical Theory and Criticism</li> <li>▪ <u>Decolonizing, Transnational, and Diaspora Criticism</u></li> </ul> </li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*Students currently registered in the program will follow the guidelines that were in place at the time of their registration.*

**Departmental approval date** (mm/dd/yy): 02/14/2019

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 02/20/2019

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts

**Program:** Doctor of Philosophy (PhD) in French Studies

**Program contact name(s):** Élise Lepage, Agata Jagielska

**Form completed by:** Élise Lepage

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements and adding a Thesis Proposal Milestone.*

**Is this a [major modification](#) to the program?** No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departement-french-studies/doctor-philosophy-phd-french-studies>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ During their second year of study, students are required to complete a set of comprehensive examinations.</li> <li>○ Prepared under the direction of the thesis supervisor, the comprehensive examinations entail both written and oral components, and are intended to ensure breadth, to assess competence in the field of French Studies, and to prepare students for the writing of the</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts Comprehensive Examination minimum requirements:</u> <ol style="list-style-type: none"> <li>1. <u>Comprehensive examination purpose: Consistent with</u></li> </ol> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>PhD thesis. <del>Three</del> components are required:</p> <ol style="list-style-type: none"> <li>1. Students prepare and read, under the supervision of their thesis advisor, a selection of primary texts, and develop a broad critical and theoretical bibliography in areas relevant to the selected thesis topic; this first component is followed by an oral examination with <del>two</del> members of their Thesis Committee.</li> <li>2. Students then write a field exam that is submitted to two members of the Thesis Committee for approval.</li> <li>3. <del>Finally</del>, students must submit, under the supervision of their thesis advisor, a <del>dissertation</del> proposal and outline of the proposed thesis. The <del>dissertation</del> proposal and outline are defended orally before all three members of their Thesis Committee. Students must successfully complete <del>all three components</del> in order to proceed to the writing of the thesis.</li> </ol>	<p><u>University-level minimum requirements.</u></p> <ol style="list-style-type: none"> <li>2. <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>3. <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Graduate Chair can approve the committee for comprehensive examinations.</u></li> <li>4. <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>5. <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>6. <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ol> <p>o <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in French Studies program are also required to meet the following requirements:</u></p> <ol style="list-style-type: none"> <li>1. During their second year of study, students are required to complete a set of comprehensive examinations.</li> <li>2. Prepared under the direction of the thesis supervisor, the comprehensive examinations entail both written and oral components, and are intended to ensure breadth, to assess competence in the field of French Studies, and to prepare students for the writing of the PhD thesis. The <u>following</u> components are required: <ul style="list-style-type: none"> <li>▪ Students prepare and read, under the supervision of their thesis advisor, a selection of primary texts, and develop a broad critical and theoretical bibliography in areas relevant to the selected thesis topic;</li> </ul> </li> </ol>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<p>this first component is followed by an oral examination with <u>all three</u> members of their Thesis Committee (<u>thesis advisor and two internal readers</u>).</p> <ul style="list-style-type: none"> <li>▪ Students then write a field exam that is submitted to their Thesis Committee for approval.</li> </ul> <ul style="list-style-type: none"> <li>• <b><u>Thesis Proposal</u></b> <ul style="list-style-type: none"> <li>○ Students must submit, under the supervision of their thesis advisor, a thesis proposal and outline of the proposed thesis. The thesis proposal and outline are defended orally before their Thesis Committee. Students must successfully complete <u>the PhD Comprehensive Examinations and the Thesis Proposal</u> in order to proceed to the writing of the thesis.</li> </ul> </li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*The Department of French Studies completely reviewed the PhD Comprehensive Examination in 2014. Minor changes (reflected in the table above) were approved at the departmental meeting of June 2018 to align the requirements with the new University-level requirements. The new, slightly modified procedure has already been in effect since July 1<sup>st</sup>, 2018. Faculty members have received a copy of the document outlining the detailed procedure of the PhD Comprehensive Examination, as well as a one-page chart capturing the different responsibilities and roles (Associate Chair – Graduate Studies, Thesis Advisor, Committee Member, PhD student).*

**Departmental approval date** (mm/dd/yy): 02/13/19

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 02/13/2019

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts

**Program:** Doctor of Philosophy (PhD) in German

**Program contact name(s):** Barbara Schmenk, Janet Vaughan

**Form completed by:**

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/department-germanic-and-slavic-studies/doctor-philosophy-phd-german>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ Candidates must pass 1 oral qualifying examination (a combined examination of both Literature/Film Studies and Applied Linguistics), and 1 written qualifying examination in the area of their dissertation research. Guidelines for Qualifying Examinations are available from the Department.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts Comprehensive Examination minimum requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements.</u></li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<ul style="list-style-type: none"> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Graduate Chair can approve the committee for comprehensive examinations.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> <li>○ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in German program are also required to meet the following requirements:</u> <ul style="list-style-type: none"> <li>▪ Candidates must pass 1 oral qualifying examination (a combined examination of both Literature/Film Studies and Applied Linguistics), and 1 written qualifying examination in the area of their dissertation research. Guidelines for Qualifying Examinations are available from the Department.</li> </ul> </li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*Our practice is in sync with the new regulations. Students already enrolled in the program have been informed of the university-level minimum requirements as well. The firm deadline for completing both comps has been communicated to all of them, including the regulations in case they do not meet the deadline.*

**Departmental approval date** (mm/dd/yy): 03/01/19

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 02/13/2019

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts and Environment

**Program:** Doctor of Philosophy (PhD) in Global Governance

**Program contact name(s):** Dan Gorman, Shelby Davies

**Form completed by:** Shelby Davies

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/global-governance/doctor-philosophy-phd-global-governance>

<https://uwaterloo.ca/graduate-studies-academic-calendar/environment/global-governance/doctor-philosophy-phd-global-governance>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>• <del>Students must write comprehensive examinations in two areas within 16 months of starting the program. Normally, students will write comprehensive exams at the end of their first year. The first examination will be on Global Governance and will test the breadth and depth of a student's comprehension of the leading literature. The Program Director will appoint three core faculty members to set the exam</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the "<a href="#">Minimum requirements for the PhD degree</a>" section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>questions and mark this first comprehensive exam. The faculty teaching the program core course during that particular year must be included among these three faculty members.</p> <ul style="list-style-type: none"> <li>• For their second area, students will choose to write a comprehensive examination in one of the five fields of the program. The Program Director, in consultation with the student and the faculty teaching the field core courses, will strike a committee of three faculty members to set the exam questions and to mark the second comprehensive exam. Students can only write an examination in a field if they have completed two courses in that field, one of which must be a “core” course for that field.</li> </ul>	<p><u>Comprehensive Examination minimum requirements:</u></p> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements. Note: in Global Governance, the committee composition may include faculty from Wilfrid Laurier University due to the joint nature of the PhD program.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul> <ul style="list-style-type: none"> <li>○ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in Global Governance program are also required to meet the following requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Students write the core Global Governance exam based on a reading list of fifty (50) works set by the core Examination Committee which is normally comprised of three faculty members, at least one of whom would have taught the Global Governance, Methods, History or Economics courses (faculty may be from either the University of Waterloo or Wilfrid Laurier University due to the joint nature of the PhD program). The list of readings will be agreed upon by all committee members and sent to</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<p><u>the students by May 1. The students will write the Global Governance exam in the beginning of September of Year Two.</u></p> <ul style="list-style-type: none"> <li>▪ <u>Students then write a field exam related to the field of their proposed dissertation topic. The field exam is set by a committee comprised normally of the student’s supervisor, the faculty member who taught the field course, and a third faculty member (faculty may be from either the University of Waterloo or Wilfrid Laurier University due to the joint nature of the PhD program). The field exam reading list will be finalized by the field committee in consultation with the student by May 1. The students will write their field exam two weeks after their core Global Governance exam.</u></li> <li>▪ <u>Outcomes of the comprehensive exam:</u> <ul style="list-style-type: none"> <li>▪ <u>Students will receive one of three evaluations of their comprehensive exam: Passed, Passed Conditionally, and Re-examination. The Examination Committee’s evaluation will be determined by majority vote, with the one exception that a student will receive an evaluation of “Passed Conditionally” where the committee returns one vote for “Passed Conditionally” and two votes for “Re-examination.” When a student receives an evaluation of “Passed Conditionally,” the Program Director will provide the student within ten (10) business days with a written report from the Examination Committee</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<p><u>that outlines specifically those parts of the student's examination that the student will need to elaborate upon and/or clarify. The student will then have thirty (30) days to submit a written response of no more than 1,000 words in which they will outline clarifications and/or revisions. The committee will then evaluate the response and determine by majority if the student has met the requirements for a "Pass." If a student fails the first sitting of their examination, either after the initial written attempt or after the Passed Conditionally stage, they have the option to sit the examination a second time. When a candidate is re-examined, the outcomes are limited to: Passed, and Exam Unsuccessful. A result of Exam Unsuccessful will normally lead to expulsion from the doctoral program.</u></p>

**How will students currently registered in the program be impacted by these changes?**

*No impact, the program was already adhering to the University/Faculty of Arts guidelines, with the exception of the committee composition. The program has approval to continue with our current practice for committee composition due to the joint nature of our program.*

**Departmental approval date** (mm/dd/yy): 02/08/2019

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 02/28/2019

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts

**Program:** Doctor of Philosophy (PhD) in Religious Studies

**Program contact name(s):** Doris Jakobsh, Carry Derome

**Form completed by:**

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

**Is this a [major modification](#) to the program?** No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departement-religious-studies/doctor-philosophy-phd-religious-studies>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ There are 2 examinations: (a) the general exam is to ensure breadth and to assess competence in the study of religion; (b) the field exam is to focus an area of specialization and to determine readiness for the dissertation project. Each examination, based on a bibliography constructed by the faculty in consultation with the student, has a written and an oral component. A candidate has only two opportunities to complete each of the examinations successfully. These examinations</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts Comprehensive Examination minimum requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with</u></li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>should take place by the end of the candidate's second year in the program. To be permitted to take the examinations at a later time, a candidate must petition the Director for an extension. Extensions are normally granted only once and then, only for one term.</p>	<ul style="list-style-type: none"> <li>▪ <u>University-level minimum requirements.</u></li> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Graduate Chair can approve the committee for comprehensive examinations.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul> <ul style="list-style-type: none"> <li>○ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in Religious Studies program are also required to meet the following requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Students must complete 2 examinations: (a) the general exam is to ensure breadth and to assess competence in the study of religion; (b) the field exam is to focus an area of specialization and to determine readiness for the dissertation project. Each examination, based on a bibliography constructed by the faculty in consultation with the student, has a written and an oral component. A candidate has only two opportunities to complete each of the examinations successfully. These examinations should take place by the end of the candidate's second year in the program. To be permitted to take the examinations at a later time, a candidate must petition the Director for an extension. Extensions are normally granted</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	only once and then, only for one term.

**How will students currently registered in the program be impacted by these changes?**

*Current students will meet the requirements that were in place at the time of their admission. Students admitted to the program after Spring/May 2019 will be required to meet the new minimum requirements.*

**Departmental approval date** (mm/dd/yy): 02/11/19

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 12/17/2018

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Arts

**Program:** 1) Doctor of Philosophy (PhD) in Sociology  
2) Doctor of Philosophy (PhD) in Sociology – Co-operative Program

**Program contact name(s):** Adie Nelson, Camille Graham

**Form completed by:** Camille Graham

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departmentsociologyandlegalstudies/doctorphilosophyphdsociology>

<https://uwaterloo.ca/graduate-studies-academic-calendar/arts/departmentsociologyandlegalstudies/doctorphilosophyphdsociologycooperativeprogramdirectentry>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ Once a student chooses a dissertation topic, they select a faculty member who is willing to supervise the dissertation.</li> <li>○ Before submitting a dissertation proposal, the student must pass 2 comprehensive examinations in substantive areas, related to the Department's PhD "fields" listed below. Students may take 2 comprehensives</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination I and PhD Comprehensive Examination II</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted exceptions that are specific to the Faculty of Arts</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>in the same field. In each comprehensive, students are expected to demonstrate a familiarity with the theoretical and methodological approaches germane to that substantive area.</p> <ul style="list-style-type: none"> <li>▪ Crime, Law, and Security</li> <li>▪ Knowledge, Education, and Digital Culture</li> <li>▪ Migration, Borders, and Transnationalism</li> <li>▪ Social Inequality and Public Policy</li> </ul> <ul style="list-style-type: none"> <li>○ Normally, students must complete their comprehensive examinations by the end of their sixth term in the program.</li> <li>○ Students may take comprehensives in one of two formats: <ul style="list-style-type: none"> <li>▪ i) a six-hour written examination; or</li> <li>▪ ii) a take-home examination with an oral defence.</li> </ul> </li> <li>○ The format will be decided in consultation with the student's Comprehensive Examining Committee.</li> <li>○ <del>Composition of Committee: the Comprehensive Examining Committee will consist of three faculty members, one of whom will serve as the Chair of the Committee. The Chair will be chosen by the student, and should be a full-time member of the Department. The two additional faculty members will be chosen by the student in consultation with the Committee Chair. Ordinarily, the other two members would also be full-time faculty appointments from the Department. All Comprehensive Examining Committees and Chairs are approved by the Department's Associate Chair, Graduate Studies.</del></li> </ul>	<p><u>Comprehensive Examination minimum requirements:</u></p> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Graduate Chair can approve the committee for comprehensive examinations.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements with the exception that in the Faculty of Arts, the Chair can be a voting member of the committee</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul> <ul style="list-style-type: none"> <li>○ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in Sociology program are also required to meet the following requirements:</u> <ul style="list-style-type: none"> <li>▪ Once a student chooses a dissertation topic, they select a faculty member who is willing to supervise the dissertation.</li> <li>▪ Before submitting a dissertation proposal, the student must pass 2 comprehensive examinations in substantive areas, related to the Department's PhD "fields" listed below. Students may take 2 comprehensives in the same field. In each comprehensive, students are expected to demonstrate a familiarity with the theoretical and methodological approaches germane to that substantive area. <ul style="list-style-type: none"> <li>▪ Crime, Law, and Security</li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<ul style="list-style-type: none"> <li>▪ Knowledge, Education, and Digital Culture</li> <li>▪ Migration, Borders, and Transnationalism</li> <li>▪ Social Inequality and Public Policy</li> <li>▪ <u>Normally, students must complete their 1<sup>st</sup> comprehensive examination by the end of their fourth term in the program.</u></li> <li>▪ Normally, students must complete their <u>2<sup>nd</sup></u> comprehensive examination by the end of their <u>fifth</u> term in the program.</li> <li>▪ Students may take comprehensives in one of two formats: <ul style="list-style-type: none"> <li>▪ i) a six-hour written examination; or</li> <li>▪ ii) a take-home examination with an oral defence.</li> </ul> </li> <li>▪ The format will be decided in consultation with the student's Comprehensive Examining Committee.</li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*Section will expand to accommodate content. Please include details here.*

**Departmental approval date** (mm/dd/yy): 01/31/19

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 01/22/2019

**Faculty approval date** (mm/dd/yy): 03/19/19

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Engineering

**Program:** Doctor of Philosophy (PhD) in Civil Engineering - Water

**Program contact name(s):** Giovanni Cascante, Zoe Tipper

**Form completed by:** Zoe Tipper

**Description of proposed changes:**

*Updating the PhD course requirements to include requirements for PhD3.*

**Is this a [major modification](#) to the program?** No

**Rationale for change(s):**

*To include requirements for those who are admitted to the PhD program without a Masters degree.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/department-civil-and-environmental-engineering/doctor-philosophy-phd-civil-engineering-water>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><b>Courses</b></p> <ul style="list-style-type: none"> <li>Students must complete 5 one-term courses (0.50 unit weight) (600 or 700 series) acceptable for graduate credit by the Department with an overall average of 70%, 2 of which must be satisfied by taking WATER 601 and WATER 602. An overall average of 70% is required for WATER 601 and WATER 602.</li> <li>This degree is offered through the Collaborative Water Program. This program, jointly offered by a range of departments across several academic faculties, promotes the development of interdisciplinary perspectives on water. Collaborative Water Program students complete their specialist</li> </ul>	<p><b>Courses</b></p> <ul style="list-style-type: none"> <li>The coursework associated with the program is intended to provide a foundation for advanced learning in the chosen field of research.</li> <li>A minimum of 5 one-term (600 or 700 series) graduate level courses (0.50 unit weight) is required for PhD students holding a Master of Applied Science (MAsc) degree or equivalent, 2 of which must be satisfied by taking WATER 601 and WATER 602. A minimum of 8 one-term (500, 600 or 700 series) graduate level courses (0.50 unit weight) with a limit of one, 500 series courses is required for PhD students coming from a Bachelors program or incomplete Master's, 2 of which must be satisfied by taking WATER 601 and WATER 602.</li> </ul>

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Science

**Program:** Doctor of Philosophy (PhD) in Pharmacy

**Program contact name(s):** Andrea Edginton, Praveen Nekkar, Melinda Recchia

**Form completed by:** Melinda Recchia

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Spring Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/science/school-pharmacy/doctor-philosophy-phd-pharmacy>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>○ <del>The second year is devoted to intensive preparation for the comprehensive examination, completion of courses and continuation of research. The comprehensive examination allows the student to demonstrate and be assessed on their breadth and depth of their knowledge as well as their ability to present their arguments in a coherent, logical and scientific manner.</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>○ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC).</u></li> <li>○ <u>In addition to the University-level PhD Comprehensive Examination minimum requirements, students in the PhD in Pharmacy program are also required to meet the following requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Students with no previous studies at the PhD level must</u></li> </ul> </li> </ul> </li> </ul>

## Handling of Final Assessment Reports & Two-Year Progress Reports related to academic program reviews

### Introduction

Waterloo's Senate Undergraduate Council (SUC) and Senate Graduate and Research Council (SGRC) have a duty to consider all aspects relating to the academic quality of undergraduate studies and graduate studies within the University. As described in Waterloo's Institutional Quality Assurance Process ([IQAP](#)), documentation emerging from the [cyclical program review](#) process includes:

- [Final Assessment Report](#), which summarizes the self-study, external reviewers' report, program response, and implementation plan, and
- [Two-Year Progress Report](#), which reports on progress related to the implementation plan.

Final Assessment Reports (FARs), require two SUC or SGRC members to review the report, whereas, Two-Year Progress Reports only require one SUC or SGRC member, although at the SUC/SGRC Chair's discretion, a second reviewer may be sought. In order to ensure that student representatives have the opportunity to review each report, the FEDS VP, Academic and GSA, President receive these documents in advance for information. Any questions or concerns they might have can be raised and addressed, if needed, prior to the report being approved at SUC/SGRC. This review process is coordinated by the Quality Assurance (QA) Office.

To promote transparency and foster integrity in the review process, reviewers should not be members of the Faculty or Affiliated and Federated Institutions of Waterloo (AFIW) from which the report originates.

### Assessment

Reviewers will consider a series of **guiding questions** (see below) in arriving at their recommendation for revision or approval to SUC or SGRC. Before reporting to SUC or SGRC, reviewers will ask questions and share their observations, as well as any concerns they have identified with the report, to the Quality Assurance Office, who will then connect with the Chair or Director of the program. The FEDS and GSA representative will also receive these reports for information prior to submission to SUC/SGRC.

The Quality Assurance Office will ensure that any revisions to the reports are completed by the Chair or Director of the program, prior to the QA Office submitting the report for approval at a SUC or SGRC.

#### Does the Final Assessment Report:

- 1) Include a credible implementation plan that not only addresses the substantive issues identified from the program review process but also identifies clearly:
  - What actions will follow from specific recommendations?
  - Who will be responsible for acting on those recommendations?
  - Who will be responsible for providing resources?
  - Priorities for implementation and realistic timelines for initiating and monitoring actions?
- 2) Provide a rationale as to why a recommendation(s) will not be pursued?

**Does the Two-Year Progress Report:**

- 1) Clearly describe progress achieved on the various action items in the implementation plan?
- 2) Explain convincingly any circumstances that would have altered the original implementation plan?
- 3) For items that are behind schedule, propose an amended implementation schedule that is reasonable and credible?
- 4) Address significant developments or initiatives that have arisen since the program review process, or that were not contemplated by the program review process?

The program Chair or Director (or their chosen delegate) will attend the SUC or SGRC meeting to address any questions or concerns that might arise during SUC/SGRC.

SUC's and SGRC's responsibility will be to focus on the overall credibility and feasibility of the report and the proposed plan of action – seeking to uncover, for example, unexplained disjunctions between the reviewers' recommendations and the program's response – as opposed to the minutiae of course content and curriculum structure.

A Final Assessment Report or Two-Year Progress Report that is approved by a majority vote of SUC/SGRC will be submitted to Senate for information. Should the discussion at SUC or SGRC reveal issues of concern that require revision, the Quality Assurance Office will work with the program Chair or Director to address the concern(s). If minor revisions are needed, the report will be edited and then it will proceed to Senate for information without re-approval from SUC/SGRC; however, any major revisions will require SUC/SGRC review and approval.

# MEMORANDUM

To: Alyssa Voigt, Quality Assurance Office

From: Jeremy Bergen

Date: April 17, 2019

Re: Review of Two-Year Progress Report for Pure Math (MMath/PhD)

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Alyssa,

I have reviewed the Two-Year Progress Report (as well as the Final Assessment Report) for Pure Math (MMath/PhD) and recommend that SGRC endorse the report.

All reports have affirmed the high quality of the program. The Final Assessment Report made five recommendations, along with timelines and accountabilities for implementation. According to the Two-Year Progress report, the first four recommendations have been implemented successfully and no further action is required. The fifth recommendation is to develop a 5-year proposal to present to Dean and Provost regarding faculty appointments required to become the strongest doctoral program of its kind in Canada. According to the report, the strategic planning that will lead to such a proposal is underway. Of course, developing a plan is not the same thing as have the resources to implement it. But the development of the plan is in process.

The program should be commended for its positive and timely responses to the recommendations.

Jeremy



----

Jeremy M. Bergen

Associate Professor of Religious Studies and Theological Studies

Director of Theological Studies

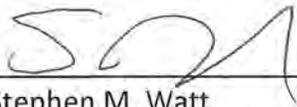
Conrad Grebel University College, University of Waterloo

July 4, 2018

**Re: Quality Assurance Office**

The Faculty of Mathematics endorses the June 2018 Two year progress report for the Pure Math (MMath/PhD) program. Pure math has completed four of the five recommendations.

The last recommendation, to build the strongest PhD program in Canada, is currently in progress. The chair of the department will be preparing a long-term plan within the next year, and this plan will need to be combined careful with the Math Faculty strategic plan.



---

Stephen M. Watt  
Dean, Faculty of Mathematics



# Two-Year Progress Report

## Pure Mathematics (MMath/PhD)

### February 2019

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#### **Background**

The program review for the graduate programs in the Department of Pure Mathematics was completed in 2016, with the final assessment report approved by the Senate Graduate and Research Council in December 2017.

The reviewers reported that the Pure Mathematics graduate programs are of very high quality, are well viewed by faculty members, students and alumni and have very good outcomes. The reviewers noted that there were no critical issues that required immediate attention.

The review made five recommendations, several of which were advice in response to topics about which their opinion had been asked. These recommendations and the actions have been taken, or will be taken; details are below. Phrases in square brackets in the statement of the recommendations were added for clarification.

#### **Progress on Implementation Plan:**

##### ***Recommendation 1.***

“We recommend that the Department not offer a direct entry to the PhD program without a MMath (or equivalent) degree.”

Status: **completed** - We are following this recommendation. No changes were made or needed.

##### ***Recommendation 2.***

“We recommend that the Department work with the Office of the Associate Provost, Graduate Studies, (now Office of Graduate Studies and Postdoctoral Affairs) to try to resolve this issue [the issue being the restricted opportunities to take 600 level courses]. On the part of the Department this may involve making the different expectations (including expected extra work) between the two groups of students [the groups being undergraduate and graduate students] clearer and more explicit in all course descriptions.”

Status: **completed** - Masters students now have access to standard graduate level courses. It is clearly understood that there are different expectations for graduate and undergraduate students when taking ‘held-with’ courses.

***Recommendation 3.***

“We recommend that the Department review the comprehensive exam procedures.”

Status: **completed** - The Graduate Officer and Graduate Committee have reviewed the procedures. A proposal to revamp PhD committees and comprehensive exams has been approved by the department, and is working its way through the university approval processes.

***Recommendation 4.***

“We recommend that the Department provide some flexibility in the MMath program.”

Status: **completed** – Flexibility, in terms of time taken to complete the degree, is provided to students on a case-by-case basis. Students typically complete in three terms, but are allowed to take longer (up to two years) in special circumstances.

***Recommendation 5.***

“The Department should write a 5 year proposal to present to the Dean and the Provost outlining a plan that would achieve this goal [to build the strongest PhD program in Canada] by making appointments above the assistant professor level.”

Status: **in progress** - The Math Faculty is currently undertaking a strategic planning process. A long-term plan for the Department will be developed by the Chair over the coming year in accordance with the Faculty strategic plan.

**Explain any circumstances that have altered the original implementation plan: N/A**

**Address any significant developments or initiatives that have arisen since the program review process, or that were not contemplated during the review: N/A**

**Report on anything else you believe is appropriate to bring to Senate concerning this program: N/A**

Updated Implementation Plan:

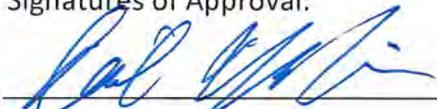
	<b>Recommendations</b>	<b>Proposed Actions</b>	<b>Responsibility for Leading and Resourcing (if applicable) the Actions</b>	<b>Timeline for addressing Recommendations</b>
1.	We recommend that the Department not offer a direct entry to the PhD program without a MMath (or equivalent) degree.	Completed	N/A	N/A
2.	We recommend that the Department work with the Office of the Associate Provost, Graduate Studies, to try to resolve this issue [the issue being the restricted opportunities to take 600 level courses]. On the part of the Department this may involve making the different expectations (including expected extra work) between the two groups of students [the groups being undergraduate and graduate students] clearer and more explicit in all course descriptions.”	Completed	N/A	N/A
3.	We recommend that the Department review the comprehensive exam procedures.	Completed	N/A	N/A
4.	We recommend that the Department provide some flexibility in the MMath program.	Completed	N/A	N/A
5.	The Department should write a 5 year proposal to present to the Dean and the Provost outlining a plan that would achieve this goal [to build the strongest PhD program in Canada] by making appointments above the assistant professor level.	The Department will develop a long range hiring plan, in consultation with the Dean, as part of the Math Faculty strategic planning process.	Chair	Spring 2019

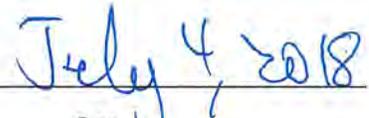
The Department Chair/Director, in consultation with the Dean of the Faculty shall be responsible for monitoring the Implementation Plan.



Date of next program review: \_\_\_\_\_ 2022 \_\_\_\_\_  
Date

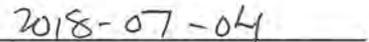
Signatures of Approval:

  
Chair/Director

  
Date

AFIW Administrative Dean/Head (For AFIW programs only) \_\_\_\_\_ Date

  
Faculty Dean

  
Date

Associate Vice-President, Academic \_\_\_\_\_ Date  
(For undergraduate and augmented programs)



December 10, 2018

Associate Vice-President, Graduate Studies and Postdoctoral Affairs \_\_\_\_\_ Date  
(For graduate and augmented programs)

## MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter  
Secretariat

Roy Brouwer  
Executive Director, Water Institute

Bernard Duncker  
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean  
Vice-President, Research and International 

DATE: Friday April 26, 2019

RE: Support for the Water Institute, University Centre

I am pleased to inform you that, following the presentation from Roy Brouwer, Executive Director of the University level Water Institute (WI), at the Research Leaders Council meeting of April 17, 2019, the Council unanimously recommends support of the renewal of the Water Institute for another five-year term to Senate Graduate and Research Council.





## MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter  
Secretariat

Roy Brouwer  
Executive Director, Water Institute

Bernard Duncker  
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean  
Vice-President, Research and International 

DATE: Tuesday April 30, 2019

RE: One-Month Extension

I have issued the university level Water Institute a 1-month extension to June 30, 2019 to accommodate the renewal process as it goes before Senate in June.



2014 / 2019

THE WATER INSTITUTE  
**FIVE-YEAR**



*Interdisciplinary  
Innovative  
International*

**REVIEW**



UNIVERSITY OF  
**WATERLOO**

the **water**  
INSTITUTE



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## Executive Summary

The Water Institute was established by the University of Waterloo in 2009 to be a global leader in interdisciplinary water research and education. The Institute facilitates interdisciplinary collaboration and knowledge exchange in addressing complex water challenges, and promotes innovation in interdisciplinary research and education. With over 150 faculty members, including more than 20 Canada and University Research Chairs, representing 23 departments and schools across all 6 faculties, the Water Institute is the largest research center on campus and the largest water research center in Canada.

Over the period 2012 to 2016, Water Institute faculty members published more water research articles than any other university in Canada. Over 50% of member publications from 2010 to 2016 were in the top quartile of water resources journals identified by the Web of Science ranked by impact factor. An independent indication of the Water Institute's strength and recognition is given in international rankings. While specific rankings for water research organizations are not widespread, several schemes have been identified over the past several years in which the Water Institute was ranked among the world's top water research institutions in the world.

**32<sup>nd</sup> Best Academic Institution for Water Resources in the World**

Shanghai Ranking of Global Universities, Water Resources, 2018

**10<sup>th</sup> Best Water Research Institution In The World**

Lux Research Inc., Top Academics and Institutions in Water Research 2013

**20<sup>th</sup> Most Prolific Water Research Institute In The World**

Stockholm International Water Institute and Elsevier,  
The Water and Food Nexus: Trends and Development of the Research Landscape, 2012

The Water Institute is currently renewing its strategic plan for the period 2020 to 2025, and has implemented a bottom-up, participatory process to ensure faculty members have the opportunity to reflect on past achievements and challenges, and to identify strategic directions and priorities for the future. Based on preliminary findings, the overriding goal for the Water Institute will be to further increase its global impact in a number of key areas, including the further development of its shared services business model, proactive enduser-based interdisciplinary water research program, and national and international outreach, for example through the organization of interdisciplinary summer schools and student innovation competitions.

The Institute operates under the authority of the Vice-President Research and is administered by a relatively modest staff (3.7 full-time equivalents). The Water Institute's Executive Director leads scientific programming. The Water Institute is governed through a Strategic Planning Committee with faculty representatives who advise the Executive Director on strategic decisions, a Senior Management Committee with faculty deans, and an External Scientific Advisory Board that includes several internationally renowned water scholars.

The Water Institute receives an annual operating budget of \$350,000 from the Provost. The Institute has been successful in supplementing the Provost's investment through various grants and contracts with external partners that have contributed about \$40,000 annually to its operating budget. Primary Water Institute expenses are staff salaries, office expenses, and program expenses. The Institute has a current structural deficit of about \$70,000 that is largely attributable to general inflation corrections to staff salaries that have occurred over the last 9 years with no commensurate increase in funding. Annual deficits have been offset by a carryforward balance that was accumulated by the Institute over its first 4 years of operations, where it underspent against budget. This carryforward balance is forecast to be exhausted at the completion of the current 2018-19 fiscal year.

In addition to the publication of a bi-weekly, digital newsletter, its own water research journal, and Water Institute member cover stories on its website, the Institute delivers various interdisciplinary programs to its faculty and student members, and to the broader stakeholder community, to transfer knowledge and facilitate the exchange of scientific information. Specific programs include the organization and delivery of the WaterTalks lecture series, annual World Water Day events, annual RBC Distinguished Lectures, WaterConnections industry liaison events, International Conferences, and an International PhD Summer School. In addition, the Institute financially supports and mentors the Water Institute Graduate Students Association (SWIGS). A key strategic goal of the Water Institute is furthermore to strengthen international networks and partnerships with leading water organizations and researchers around the world. To this end, the Institute has developed a network of partnerships with leading water research and education institutes worldwide.

In 2014, the Water Institute launched the innovative Collaborative Water Program (CWP) that provides graduate students with a broad, interdisciplinary foundation in water science, engineering, economics and governance, beyond the specialist training they continue to receive in their home departments or schools. The Water Institute worked closely with Advancement to secure a substantial gift of \$1.75 million from the RBC Foundation to support the development and delivery of the CWP. Eleven departments/schools currently deliver the CWP, with the Water Institute providing coordinated central support to the program director, faculty, and students. Since the program launch, 255 students have participated. Since 2011-12, the Water Institute has provided over \$1 million in scholarships to over 130 graduate students in various water-related programs, including the CWP. In addition, the Institute was granted \$150,000 by the RBC Foundation to develop the RBC Visiting Fellows program which attracts internationally renowned scholars to campus to enrich the learning experience of water students, and to stimulate discussion with faculty members.

From 2009-10 to 2017-18, Water Institute researchers were awarded over \$166 million in research grants and contracts, which represented about 10% of total University of Waterloo research funding over this period. Twenty-two percent of this funding (\$35 million) can be directly traced back to the Water Institute, implying a Return on Investment (ROI) of 11.1 over 9 years compared to the University's investment in the Water Institute over the same period. This additional, incremental funding would not have occurred without the leadership and support of the Water Institute. Moreover, over the past several years, Water Institute affiliated faculty members and students have established several water-technology start-up companies which were directly and indirectly supported by the Institute, for example by delivering the AquaHacking student innovation competition.

Since 2011, the Provost has provided earmarked funding to the Water Institute to develop and administer a Seed Grants program. The program provides modest grants to faculty members to stimulate interdisciplinary collaboration, new proposals and funding. Based on input received from faculty in developing the new strategic plan, it is clear that members place great value on the ability of the program to catalyze new partnerships, research areas, and funding. To-date, the Seed Grants program has resulted in over \$5 million in new, "downstream" research funding, implying a ROI of 9.6 over 7 years. The Institute therefore respectfully requests that the current seed grant funding level of \$150,000 per year be maintained for the period 2019-20 to 2023-24.

Since 2017-18, the Water Institute has pioneered an innovative "shared services" business model, where specific services delivered by Institute staff are paid for by Institute members through their research projects. While working with Principal Investigators and supporting specific projects, these staff remain under the management and administration of the Water Institute. The shared services model currently contributes about \$120,000 per year to offset the salaries of the Water Institute Knowledge Mobilization Specialist and Communications Officer. During the period 2019-20 to 2023-24, the Institute intends to consolidate and, where possible, expand its shared service offering to include Project Management services.

The Water Institute Five-year Review Report and renewal request presents two budget scenarios for the period 2019-20 to 2023-24:

- Scenario 1 - Funding Maintained at the Current Level, and
- Scenario 2 - Programming Maintained at the Current Level.

Results from Scenario 1 indicate that funding at this level (\$350,000 per year) will only cover salary and (partial) office expenses in early years, and will be totally consumed by salaries by year 5. No Water Institute programming as outlined above will be possible in any year under Scenario 1. Results from Scenario 2 indicate that an increase of \$100,000 per year to the Water Institute's operating budget – from \$350,000 to \$450,000 – will allow the Institute to maintain its programming and value to members under the current institutional structure.

The renewal of the Water Institute, and maintenance of its high quality services and programming, is essential to the achievement of the University of Waterloo's current and emerging strategic goals. The Institute is growing the University's brand, reputation, and impact nationally and globally by creating a collaborative network that moves beyond disciplinary silos in catalyzing excellence in interdisciplinary research, by shaping extraordinary talent through interdisciplinary education, and by making a real impact around the world in advancing the sustainable management of water for the benefit of the environment, economy and society.

# 1. Institutional Background

## 1.1 Establishment

The decision to collect the University of Waterloo's strength and interests in water research and education within the common envelope of an institute grew out of the "UW Sixth Decade Plan (2007)". The plan states: *"To create a critical mass of scholars and research support infrastructure, UW will promote the creation of Senate-approved research centres and institutes. By 2017, UW will have the following research infrastructure in place: at least six research centres/institutes supported by institutional funding, recognized by peer evaluation to be among the several best in the world"*

In 2007 the Vice President Academic and Provost established the Task Force on Water Research, charged with developing a conceptual proposal to establish a water institute. The report of the Task Force was approved by Dean's Council on May 21, 2008, supporting the development of a full proposal.

The proposal for development of the Water Institute recognized the strengths and diversity of the University's existing programs, and also the potential for further growth. In particular, population growth, urbanization, climate change, intensification of agricultural production and resource extraction/development were identified as factors leading to greater complexity in water management issues. In response, the proposal argued for greater interdisciplinary efforts in both research and teaching programs. The proposal to develop the Water Institute was approved by the Senate Graduate Research Council on April 13, 2009 and by Waterloo's Senate on May 19, 2009.

Further support of water research at the University was provided in the 2013-2019 strategic plan which states that *"Waterloo will continue to support and nurture the interdisciplinary culture that fuels its globally recognized research institutes"*, and identifies water as one of three areas of particular focus.

Following its establishment in 2009-10, the Water Institute delivered its first five-year review to the Senate Graduate and Research Council in June 2014 and was approved for an additional five-year term.

## 1.2 Vision, Mission and Goals

The Water Institute's 2014 to 2019 strategic plan was developed through a bottom up, participatory process with members and stakeholders. The plan articulates the Institute's vision, mission and goals for the period as follows:

- Vision:**
- To be a global leader that substantially advances the sustainable use and management of water for the benefit of the environment, economy and society.
- Mission:**
- To facilitate collaboration, support excellence and promote innovation in interdisciplinary research and education, and to promote knowledge exchange in addressing complex water challenges.
- Research Goals:**
- Promote and support relevant, collaborative, interdisciplinary water research.
  - Strengthen global networks and partnerships with leading water organizations and researchers.
- Education and Training Goals:**
- Promote interdisciplinary perspectives in water-related education.
  - Strengthen the capacity of water resources professionals.
- Brand Goals:**
- Increase the Water Institute's profile.

Section 5.1 includes a summary of progress against the specific goals and objectives of the Water Institute's 2014 to 2019 strategic plan.

### 1.3 Activities and Services

The Water Institute does not have the financial resources to fund specific research projects. Its primary functions therefore include coordination, facilitation and communication in support of various research, education, partnership, communications and knowledge mobilization activities. Specific services provided by the Institute include:

#### Research

- Identify funding opportunities and secure incremental funding
- Identify, introduce and support researchers with common areas of interest
- Provide review and advice on research proposals
- Identify partners and solicit letters of support for research projects
- Lead and manage new interdisciplinary research projects
- Provide central support (eg, project management, communications, knowledge mobilization) to faculty member research projects
- Administer the Water Institute Seed Grant program

#### Education

- Co-ordinate and support the Collaborative Water Graduate Program
- Support and enable the Water Institute's graduate student chapter (SWIGS)
- Support and organize WaterTalks lecture series, distinguished lectures, symposia, conferences and other water-related events

#### Partnerships

- Cultivate public sector, private sector, civil society, Indigenous and other partnerships/sponsorships
- Facilitate and support international collaborations and partnerships
- Organize and lead faculty delegations to water centres in other countries
- Host academic delegations at Waterloo
- Host academic visitors (professors, students) at the Water Institute
- Serve as a central point of contact

#### Communications

- Communicate and promote institute, researcher and student impact through various print (eg, impact report, WaterResearch magazine, brochures) and digital (eg, website, videos, social media, WaterNews newsletter) channels
- Work with other university communications units to leverage and profile member stories
- Facilitate and support media relations
- Provide HQP training

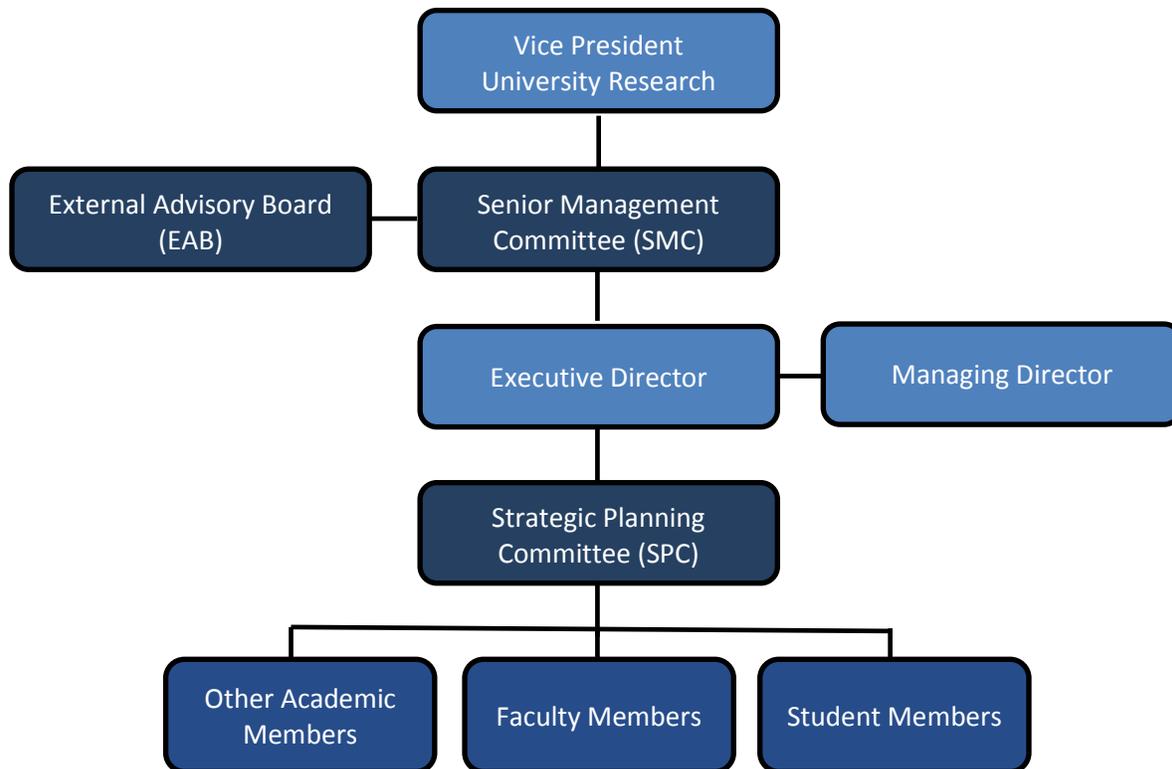
#### Knowledge Mobilization

- Provide centralized support to member research projects
- Provide HQP training

## 1.4 Governance

The governance structure of the Water Institute was originally codified in the initial Water Institute Proposal (March 2009) and the inaugural Business Plan (December 2010). The structure was amended in 2016 taking into account experience over the Institute's first five years of operation, and to ensure conformance with the University's Policy 44 on Research Centres and Institutes.

The governance structure of the Water Institute is shown schematically in Figure 1. Consistent with the interdisciplinary nature of the Water Institute, the administrative authority is vested in the Office of Research rather than in an individual faculty, with the Vice President University Research having final authority.



**Figure 1: Water Institute Governance Structure**

The Strategic Planning Committee (SPC) is the Water Institute's primary advisory body. The SPC provides:

- Direction and advice on the development and implementation of Water Institute strategies, programs and initiatives;
- Advice on Water Institute operations;
- Oversight and recommendations on Water Institute finances.

Significant recommendations of the SPC, such as the strategic plan, require approval by the Senior Management Committee and the Vice President University Research.

The SPC is chaired by the Water Institute Executive Director and is comprised of representatives from each participating faculty, in addition to the Collaborative Water Program Director, the Students of the Water Institute

Graduate Section Chair, and two faculty members-at-large. Current members of the Water Institute SPC are shown in Table 1.

<b>Table 1: Strategic Planning Committee Members</b>		
<b>#</b>	<b>Category</b>	<b>Member</b>
1.	Water Institute Executive Director (Chair)	Roy Brouwer
2.	Vice President University Research or designate	Bernie Duncker
3.	Faculty of Applied Health Sciences	Craig Janes
4.	Faculty of Arts	Margaret Insley
5.	Faculty of Engineering	James Craig
6.	Faculty of Environment	Susan Elliott
7.	Faculty of Mathematics	Kevin Lamb
8.	Faculty of Science	Heidi Swanson
9.	Students of the Water Institute Graduate Section Chair	Mark Ranjram
10.	Collaborative Water Program Director	Rob de Loë
11.	Faculty member-at-large	Philippe Van Cappellen
12.	Faculty member-at-large	Peter Huck

The Senior Management Committee (SMC) is the Water Institute’s primary governance and decision making body. The SMC:

- Provides senior leadership advice to the Executive Director;
- Seeks opportunities for the Water Institute;
- Recommends new programs and initiatives in support of the goals of the Water Institute;
- Monitors progress against the Water Institute’s Strategic and Business Plan;
- Considers, for approval, recommendations brought forth by the SPC.

The SMC is chaired by the Vice President University Research (or delegate) and includes Faculty Deans and Department/School representatives. Current members of the Water Institute SMC are shown in Table 2.

<b>Table 2: Senior Management Committee Members</b>		
<b>#</b>	<b>Category</b>	<b>Member</b>
1.	Vice President University Research or delegate (Chair)	Charmaine Dean
2.	Dean of the Faculty of Applied Health Sciences	Paul Stolee
3.	Dean of the Faculty of Arts	Douglas Peers
4.	Dean of the Faculty of Engineering	Pearl Sullivan
5.	Dean of the Faculty of Environment	Jean Andrey
6.	Dean of the Faculty of Mathematics	Stephen Watt
7.	Dean of the Faculty of Science	Bob Lemieux

#	Category	Member
8.	Chair of the Water Institute External Advisory Board	Tony Maas
9.	Water Institute Executive Director	Roy Brouwer
10. – 17.+	One faculty member from a minimum of seven different departments or schools participating in the WI	At large

The Water Institute External Advisory Board (EAB) reports to the SMC and provides:

- An independent external evaluation of the Water Institute’s progress;
- Recommendations and support to help the Water Institute meet its goals;
- Advice on new and emerging areas of water research that could be explored by Water Institute members.

The EAB held its inaugural meeting on April 23, 2013, and has had subsequent meetings in May 2014, May 2015 and October 2016. During 2017, the Water Institute Executive Director led an effort to reconstitute the Board with a particular focus on increasing international scientific representation. This plan was approved by the SPC and SMC on April 6, 2017 and May 1, 2017 respectively. In September 2018, the reconstituted External Advisory Board held their first meeting. The Board issues a report on findings to the SMC following each meeting.

Current members of the External Advisory Board are shown in Table 3.

#	Member	Title
1.	Tony Maas (Chair)	Director Forum for Leadership on Water Kitchener, Ontario, Canada
2.	Ana Deletic	Professor and Pro Vice-Chancellor (Research) University of New South Wales Sydney, N.S.W., Australia
3.	Robyn Kurtes	Director, Environmental Policy Branch Ontario Ministry of Environment and Climate Change Toronto, Ontario, Canada
4.	Tove Larson	Professor and Directorate Member Department of Urban Water Management Eawag, Dübendorf, Switzerland
5.	Mark van Loosdrecht	Professor Department of Biotechnology TU Delft, Delft, The Netherlands
6.	Mike Murray	Chief Administrative Officer Region of Waterloo Kitchener, Ontario, Canada

#	Member	Title
7.	Wu Jern Ng	Professor Environmental Bio-innovations Group Nanyang Technological University, Singapore
8.	Merrell-Ann Phare	Executive Director/Legal Counsel Centre for Indigenous Environmental Resources Winnipeg, Manitoba, Canada
9.	Joan Rose	Homer Nowlin Chair in Water Research Michigan State University East Lansing, Michigan, U.S.A.
10.	Georg Teutsch	Scientific Director Helmholtz Centre for Environmental Research – UFZ Leipzig, Germany
11.	Zhongbo Yu	Professor and Dean, College of Hydrology and Water Resources Hohai University Nanjing, Jiangsu, China

## 1.5 Membership

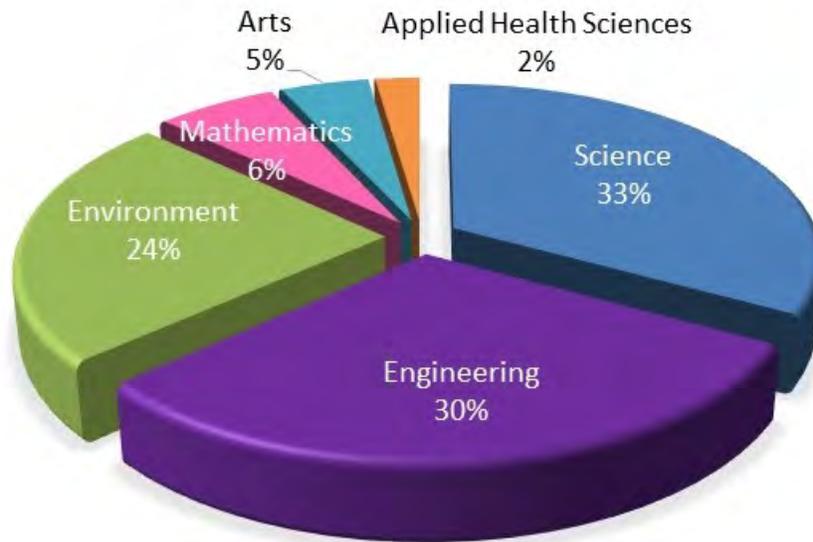
### 1.5.1 Faculty Members

All University of Waterloo faculty members, research professors and post-doctoral fellows with a component of their research devoted to water are eligible to be members of the Water Institute. The Water Institute currently has 154 faculty members, up from 120 faculty members in 2009/10. Appendix A includes a complete list of current faculty members. Faculty members come from all six academic faculties and 23 departments or schools. The distribution of members by departments or schools is given in Table 4, while Figure 2 shows the distribution across faculties.

Faculty/College	Department	# of Members
Applied Health Sciences	Public Health and Health Systems	2.5 *
	Recreation and Leisure Studies	1
Arts	Accounting and Finance	1
	Economics	3.5 *
	Philosophy	1
	Political Science	1.5 *
Environment	Environment, Resource and Sustainability	7.5 *
	Environment, Enterprise and Development	7
	Geography and Environmental Management	19

<b>Faculty/College</b>	<b>Department</b>	<b># of Members</b>
	Planning	2.5 *
Engineering	Architecture	1
	Chemical Engineering	11
	Civil and Environmental Engineering	20.5 *
	Electrical and Computer Engineering	3
	Mechanical and Mechatronics Engineering	4
	Systems Design Engineering	7
Mathematics	Applied Mathematics	5
	Computer Science	3.5 *
	Statistics and Actuarial Science	1
Science	Biology	21
	Chemistry	7
	Earth and Environmental Sciences	22.5 *
Renison College	Social Development Studies	1
<b>Total</b>		<b>154</b>

Notes  
\* Includes 0.5 allocation for jointly-appointed members.



**Figure 2: Membership by Faculty**

### 1.5.2 Research Chairs and Special Awards

As a further indication of quality, 27 members of the Water Institute hold academic Chair positions, including a highly prestigious Canada Excellence Research Chair Laureate. This exceeds the number held by any other Canadian University in the area of water research.

Canada Excellence Research Chairs (CERC) are awarded only to exceptional scholars in Canada. The following CERC Laureate has established an ambitious research program and is a member of the Water Institute:

Philippe Van Cappellen  
Ecohydrology

Canada Research Chairs (CRC), funded through the federal government, are awarded only to top researchers in Canada. The following CRC's are members of the Water Institute:

David Blowes  
Groundwater Remediation

Janusz Pawliszyn  
New Analytical Methods and Technologies

Zhongwei Chen  
Advanced Materials for Clean Energy

Carolyn Ren  
Droplet Microfluidics and Lab-on-a-Chip Technology

James Craig  
Hydrologic Modelling and Analysis

Mark Servos  
Water Quality Protection

Brian Dixon  
Fish and Environmental Immunology

Maria Strack  
Ecosystem and Climate

Christine Dow  
Glacier Hydrology and Ice Dynamics

Alexander Wong  
Artificial Intelligence and Medical Imaging Systems

Laura Hug  
Environmental Microbiology

John Yeow  
Micro and Nanodevices

Sriram Narasimhan  
Smart Infrastructure

Norman Zhou  
Advanced Materials Joining and Processing

Industrial Research Chairs (IRC) are awarded by the Natural Sciences and Engineering Research Council of Canada to researchers with strong links to business and industry, and are supported directly by industrial partners. The following IRCs are Water Institute members:

Peter Huck  
Water Treatment

Janusz Pawliszyn  
New Analytical Methods and Technologies

University Research Chairs (URC) are appointed by the University of Waterloo to recognize exceptional achievement and pre-eminence in a particular field of knowledge. The following URCs are members of the Water Institute:

Roy Brouwer  
Water Resources Economics

Pu Chen  
Nano-Biomaterials

Claude Duguay  
Cyrosphere and Hydrosphere from Space

Xianshe Feng  
Membrane Science and Technology

Juewen Liu  
Bionanotechnology

Shesha Jayaram  
High Voltage Engineering

Daniel Scott  
Global Change and Tourism

Heidi Swanson  
Freshwater Ecology

Michael Tam  
Functional Colloids and Nanomaterials

Olaf Weber  
Environmental Finance

Norman Zhou  
Advanced Materials Joining and Processing

The Centre for International Governance Innovation (CIGI) is an international think tank based in Waterloo, designed to address international governance challenges through world-class research. CIGI funds research chairs at the University of Waterloo as part of its mandate, and the following CIGI research chair is a member of the Water Institute:

Thomas Homer-Dixon  
CIGI Chair of Global Systems

Members of the Water Institute have received numerous prestigious awards, including two with the Order of Canada and seven Fellows of the Royal Society:

Order of Canada

Robert Gillham  
Keith Hipel

Fellows of the Royal Society

David Blowes  
Robert Gillham  
Keith Hipel  
Bruce Mitchell  
Janusz Pawliszyn  
Edward Sudicky  
Philippe Van Cappellen

### 1.5.3 Student Members

All University of Waterloo graduate students with an interest in water are eligible to be student members of the Water Institute through the Students of the Water Institute Graduate Section (SWIGS). The Water Institute supports the program and activities SWIGS by providing core funding, office and meeting space, guidance, and advice. The Institute established SWIGS in 2010 to promote interdisciplinary water research and learning among

graduate students from various academic faculties and, since that time, SWIGS has been active and has made a valuable contribution to the Water Institute.

By 2018-19, SWIGS had over 300 graduate student members from across all six faculties. Led by an executive committee made up of six graduate students, SWIGS has successfully planned, organized and executed a variety of academic, social and community-outreach events focused on water-related themes that have all been well attended.

From 2010-11 to 2017-18, an annual World Water Day Graduate Research Fair was organized and co-hosted by the Water Institute, SWIGS and Wilfrid Laurier University. The event featured activities such as student posters, industry booths, key note speakers, and a networking reception. In 2018-19, the Water Institute assumed responsibility for organizing the World Water Day event, with the support of the SWIGS executive committee.

#### 1.5.4 Administration

The Water Institute administration is modest, with a focus on providing support to, and promoting the work of its faculty and student members. Table 5 summarizes the current administration. Figure 3 shows the administrative structure. As noted in Table 5, the Water Institute has been successful in implementing a “shared service” model, where specific central resources managed and administered by the Water Institute Managing Director (ie, communications, knowledge mobilization) are funded directly by faculty member research projects. This business model is discussed in Section 4.4.

<b>Position</b>	<b>Incumbent</b>	<b>FTE<sup>1</sup></b>	<b>Notes</b>
Executive Director	Roy Brouwer	0.5	50% WI Executive Director, 50% Department of Economics
Managing Director	Kevin Boehmer	1.0	
Communications Officer	Amy Geddes	1.0	
Administrative Associate	Mary Anne Hardy	0.7 <sup>2</sup>	
Knowledge Mobilization Specialist	Nancy Goucher	1.0	100% salary charged to research project
Communications Officer	Allie Dusome	1.0	80% salary charged to research projects
Totals		5.2	
Totals (less shared)		3.4	
Notes:			
<sup>1</sup> Full Time Equivalent			
<sup>2</sup> Switched back from reduced workload (0.7 FTE) to full-time workload (1.0) in December 2018.			



**Figure 3: Administrative Structure**

The Water Institute Executive Director reports to the Vice President University Research and is responsible for overall leadership of the Institute. The Executive Director oversees management of the Institute, supervision of the Managing Director, and, in particular, leads the Water Institute’s scientific agenda, research and education programming, and international outreach and profiling efforts, with input from the SPC, SMC and EAB. The Executive Director is appointed by the Vice President University Research on the recommendation of the membership, for a renewable, five-year term.

Dr. David Rudolph was the inaugural Executive Director of the Water Institute, serving in this capacity from May 2009 to February 2012. Dr. Robert Gillham assumed responsibilities as Executive Director from February 2012 to December 2015. Dr. Roy Brouwer joined the Water Institute as Executive Director in January 2016.

The Water Institute Managing Director reports to the Executive Director and has responsibility for all aspects of business leadership, partnership development and day-to-day management of the Institute, including the hiring and supervision of other staff members. The Managing Director has specific responsibility for preparation and management of the annual budget, and the planning and execution of research, education, communications and knowledge mobilization programming. Kevin Boehmer is the inaugural Managing Director of the Water Institute, joining the organization in July 2011 as a full-time employee.

In 2017, the Water Institute added a Knowledge Mobilization Specialist position that is fully-funded for seven years from the Global Water Futures research project. The Knowledge Mobilization Specialist is responsible for defining research needs with science users, and for engaging and communicating with stakeholders throughout the research process. Kara Hearne was the inaugural Knowledge Mobilization Specialist, serving from August 2017 to March 2018. Nancy Goucher joined the Institute as Knowledge Mobilization Specialist in June 2018.

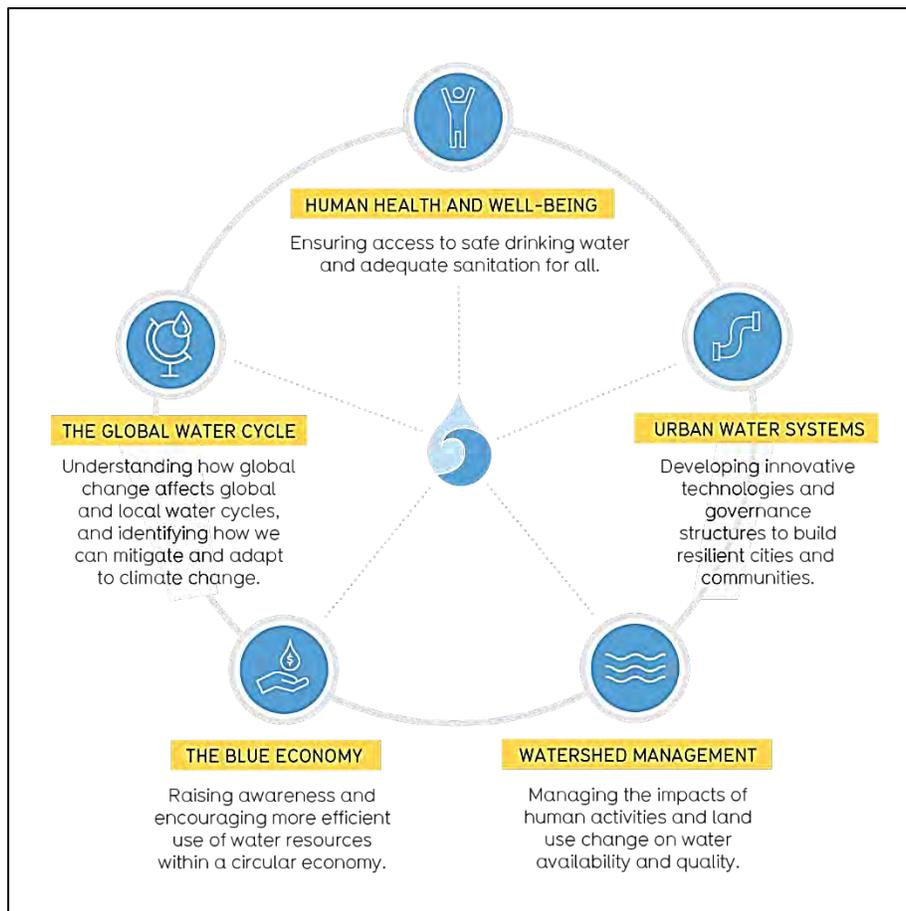
The Water Institute Communications Officers plan, implement and evaluate marketing and communications programs, activities and products to advance the Water Institute’s image, profile and reputation. The Officers develop, maintain and execute an integrated strategy, create content, develop and maintain print and digital channels, and collaborate with internal and external partners. Amy Geddes joined the Water Institute in May 2016 as its inaugural Communications Officer. Allie Dusome joined the Institute in the same capacity in January 2017. Allie’s salary is currently 80% covered through member research projects.

The Water Institute Administrative Officer reports to the Managing Director and manages general office operations. Particular responsibilities include office administration, financial accounting, research project support, logistical support with events, providing support to the Collaborative Water Program and communications with members. Mary Anne Hardy is the inaugural Water Institute Administrative Associate, joining the Institute in March 2010.

## 2. Scientific Direction

The University of Waterloo has a reputation for excellence in water research and education that reaches back over five decades. There are currently over 150 professors who are members of the Water Institute, representing all six academic faculties on campus. Based on an international benchmark study conducted in April 2016 (which is currently being updated), the Water Institute is the largest interdisciplinary water research center in Canada and among the largest in the world. Because of the large number of researchers, and the range in academic backgrounds, our research programs are diverse, and collectively comprehensive. This breadth in research is both an opportunity and a challenge.

An important objective of the Water Institute over the past several years was to facilitate the development of key themes where the interdisciplinary work of our water scientists, engineers, economists, and governance specialists can make a difference. After extensive discussions with the Strategic Planning Committee and individual faculty members, five themes were identified as an overarching framework to organize and promote past research, and as a means to catalyze and develop new research (Figure 4). The themes integrate disciplinary perspectives cascading up from individual human health, to urban water systems, watersheds, blue economies, and global climate and water systems.



**Figure 4: Water Institute Research Themes**

## 2.1 Human Health and Well-Being

Water is fundamental to human health and a key social justice issue. Lack of access to safe drinking water and adequate sanitation is one of the greatest human health and environmental threats facing the world's most vulnerable. According to the United Nations, almost 1,000 children die each day due to preventable water and sanitation-related diarrhoeal diseases. The United Nation's Sustainable Development Goal 6 calls for universal access to clean, affordable drinking water and sanitation for all by the year 2030. Many of the world's poor or vulnerable live in water-stressed areas where problems of water scarcity and contamination are increasing.

Current Water Institute research within Human Health and Well-being includes:

- Understanding relationships between the environment, water, and human health;
- Effective water and sanitation schemes for maternal and child health;
- Understanding the burden of, and risks for, waterborne infectious diseases in human populations;
- Assessing the impact of the extractive industry on public health;
- Developing integrated health impact assessment concepts and methods;
- Understanding the impact of natural disasters on community and human health;
- Developing nano-sensors and lab-on-chip devices to test water quality.

## 2.2 Urban Water Systems

Cities require adequate water supplies and the ability to treat wastewater in order to thrive. Urban water systems have traditionally focused on the provision of safe drinking water, the collection and treatment of wastewater, and more recently, stormwater and protection against flooding. In high-income countries, these systems have had an enormous positive impact on public health and safety, and on ecosystem protection. However, these urban water systems are capital intensive, largely relying on a network of ageing distribution and collection pipes linked to homes and centralized treatment facilities. The implementation of such systems in rapidly urbanizing cities in low-income countries and in emerging economies, which are often located in water stressed areas, presents unique challenges, that require innovative technologies, smart spatial planning, and strong institutions to achieve more sustainable and economically-viable urban water solutions.

Current Water Institute research within Urban Water Systems includes:

- Investigating innovative and emerging drinking and wastewater treatment processes and technologies;
- Investigating the production of bio-energy and bio-chemicals from biomass, and nutrient recovery from organic waste and wastewater;
- Assessing the fate and removal of emerging contaminants in wastewater systems;
- Investigating the use of nano-materials in wastewater treatment and nano-devices for detection;
- Assessing the impacts of climate change on water treatment systems;
- Developing water and wastewater infrastructure asset management tools;
- Evaluating the environmental exposure and effects of emerging contaminants in aquatic systems;
- Conducting field and numerical modelling studies on urban river mechanics, hydraulics, and hydrology;
- Undertaking river restoration/rehabilitation and aquatic habitat improvements;
- Developing risk assessment and management approaches for priority substances;
- Developing integrated management approaches, including land-water management, demand-focused water strategies, and the use of market-based policy instruments.

## 2.3 Watershed Management

Watersheds are an important hydrologic unit for understanding natural and ecologic functions, and for understanding how human activities affect them. Watersheds supply ecosystem services such as drinking water, water for agriculture and industry, habitats for terrestrial and aquatic species, and recreational opportunities for rural and urban communities.

The impacts of human activities on watersheds, however, are increasingly threatening their ability to produce sufficient quantities of clean water necessary to promote human health and economic prosperity. Investigating the biophysical linkages between watershed components, between groundwater and surface water, water quantity and water quality, terrestrial and aquatic systems, is critical for scientific discovery, and for the design of effective management responses that address drivers of change, while balancing competing water demands with human aspirations and ecosystem health.

Current Water Institute research within Watershed Management includes:

- Characterizing interconnected surface and groundwater systems;
- Developing coupled surface and subsurface hydrologic models at mixed spatial and temporal scales;
- Assessing the effects of human activity and multiple stressors (eutrophication, acidification, climate change, river regulation, urbanization, species invasions) on watershed hydrology, water quality, biogeochemical processes, and aquatic systems;
- Advancing the understanding of the fluxes and transformations of nutrients (phosphorus, nitrogen, silicon) and metals at the groundwater-surface water interface;
- Defining wetland and lake ecological functions and stressors;
- Developing “smart” watershed data integration platforms to monitor conditions in real-time;
- Developing improved techniques for the prediction, remediation and prevention of groundwater contamination;
- Designing cost-effective ecological restoration and conservation activities;
- Identifying and assessing, including economically, water policy and governance arrangements, including integrated land-water management, drinking water source protection planning, and forest management-based approaches for water treatment resiliency.

## 2.4 Blue Economy

The blue economy envisages the more effective and efficient use and management of water resources within a more sustainable circular economy. Global water security is threatened by growing demand, limited, unpredictable, or contaminated local supplies, and by increased uncertainty and variability in supply from climate change. Meeting these challenges requires the development and implementation of innovative water technology and, at the same time, behavioural changes. While these push/supply and pull/demand factors ideally work together, they often lack the necessary institutional-economic co-ordination and governance structures.

In moving towards a blue economy, various disciplinary perspectives need to be integrated to develop evidence-based economic, technological, institutional, and political approaches and mechanisms to reconcile economic prosperity with improvements to human health and long-term environmental sustainability.

Current Water Institute research within Blue Economy includes:

- Determining the value of water and aquatic ecosystem services;
- Defining market-based instruments for water management, including water pricing;

- Linking and integrating water accounts and economic accounting systems;
- Developing integrated hydro-economic models to support water decision-making and policy at the watershed scale;
- Studying the treatment of water risks and opportunities in corporate water management;
- Calculating the water footprint of organizations and products;
- Developing smarter and more efficient water technologies and systems;
- Defining innovative, transboundary water governance models.

## 2.5 Global Water Cycle

The water cycle links the Earth's lands, oceans, and atmosphere in an integrated global system. Researching the cycling of water through this system is key to understanding the science of water's storage and movement, and how human activities, such as urbanization, deforestation or dam building, impact not only the water cycle, but also related climatic and biogeochemical cycles.

Climate change is making the global water cycle less predictable, and reduces the stability of food, energy and urban systems. By better understanding how climate change is increasing the variability and intensity of rain events, and the associated risk of flooding or drought, more effective approaches can be designed to mitigate or adapt to its impacts.

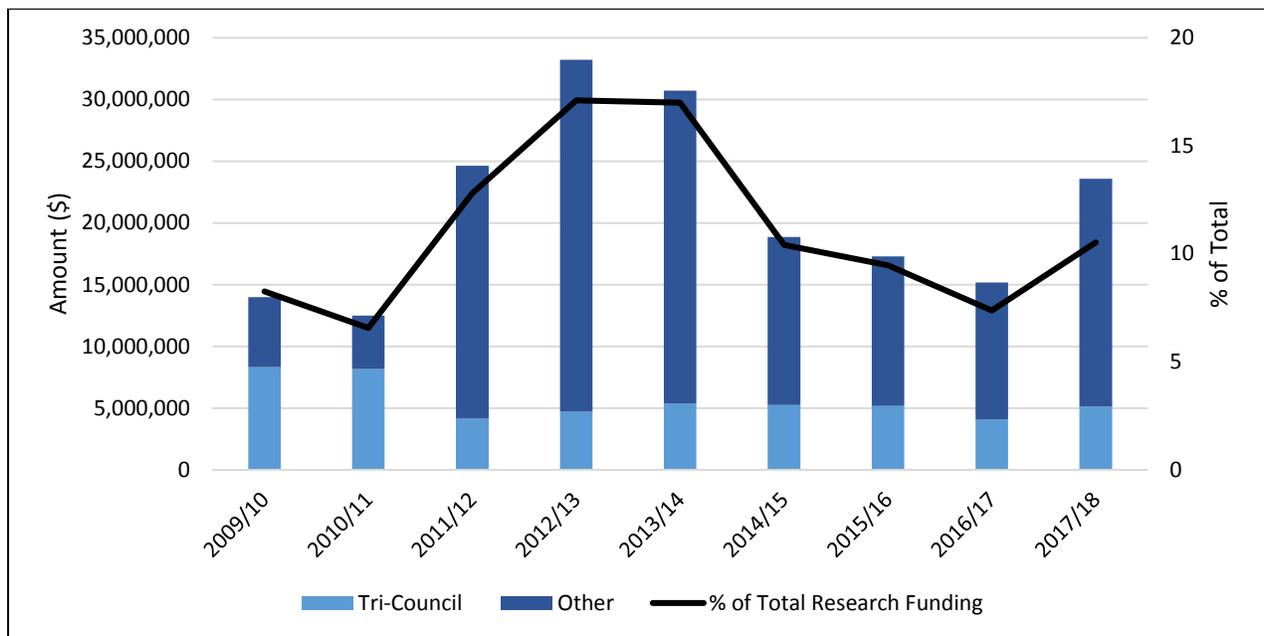
Current Water Institute research within this theme includes:

- Optimizing the calibration of atmospheric and hydrologic models;
- Estimating hydrologic extremes, and quantifying uncertainty, under various climate change scenarios;
- Investigating linkages between hydroclimatology, biogeochemical cycling, and surface-water chemistry;
- Understanding physical processes in oceans, lakes, and wetlands and their effects on biogeochemical processes;
- Observing snow and ice hydrology through remote sensing, modelling, and in situ measurement;
- Understanding the effects of climate change on aquatic food webs;
- Examining the hydrodynamics of lakes and wetlands;
- Assessing water-related impacts and vulnerabilities from climate change;
- Identifying cost-effective mitigation and adaptive management strategies at multiple governance levels.

### 3. Achievements and Results

#### 3.1 Incremental Research Funding

Figure 5 shows the estimated value of research grants and contracts of Water Institute members over the period 2009-10 to 2017-18. Water Institute researchers were awarded over 166\$million during this period, which represented about 10% of total University of Waterloo research funding during the same period. Some of this research funding was obtained by the Water Institute faculty members independent of the Institute. However, a significant portion of the funding was obtained with indirect or direct Water Institute support. Water Institute staff have made significant efforts in tracking and tracing the incremental value of the Water Institute in research fund acquisition, including through membership surveys.



**Figure 5: Total Water Research Funding 2009-10 to 2017-18 (Office of Research)**

Many researchers routinely affiliate with the Institute in proposals, including text about the Institute’s breadth of scientific excellence, its support to students through the Collaborative Water Program and other knowledge transfer activities, and through its project support capabilities (shared services), which reflects positively during evaluations. A concrete example of this indirect support and influence can be found in the following quotes from a report submitted by an NSERC site visit committee that positively evaluated a large Water Institute member proposal in 2018:

*“the applicants will be encouraged to take advantage of additional financial support, access to a broader set of expertise, and opportunities to collaborate across disciplines, through the University of Waterloo’s innovative Water Institute”*

*“the students spoke highly of the enhanced opportunities offered by the Water Institute, which includes two additional, collaborative courses focused on interdisciplinarity in the field of water research, as well as workshops, seminars, talk series, invited speakers, industry panels etc.”*

*“committee members were made aware of considerable expertise within the team, as well as knowledge mobilization expertise at the Water Institute, that could be brought to bear on the challenge of knowledge translation to the non-science based stakeholders”*

*“ the intellectual resources offered by the Water Institute were deemed outstanding”*

*“the University’s interest in seeing the project proceed was clear. Support from the Water Institute, in particular, was compelling. They offer an exciting complementary dimension to the project’s possibilities”*

More directly, the Water Institute, through its Executive Director and the Canada Excellence Research Chair Laureate, has played a central role in developing and supporting new funding proposals that has resulted in about \$35million in incremental water research funding since 2009-10 (Table 6). It should be noted that while the Tri-Council funds an important component of Water Institute member research, other sources (eg, CFREF, Provincial, Industry) account for the majority of funds.

**Table 6: Incremental Water Research Funding Since 2010**

Years	Program/Project	Principle Investigator	Amount (\$M)
2010-17	Canada Excellence Research Chair in Ecohydrology	Philippe Van Cappellen	10.0
2010-18	Southern Ontario Water Consortium	Dave Rudolph	8.0
2012-13	Micro-satellites in Water Resources Management	Bob Gillham	0.5
2017-22	Legacies of Agricultural Pollutants	Philippe Van Cappellen	0.7
2017-24	Global Water Futures	Philippe Van Cappellen	15.0
2017-20	Queen Elizabeth Scholars – Advanced Scholars	Roy Brouwer	0.5
2018-19	Water and Sanitation for the Urban Poor, Bangladesh	Roy Brouwer	0.15
<b>Total</b>			<b>34.85</b>

**Over the period 2009-10 to 2017-18, 22% of all water research funding acquired by Water Institute members (\$166 million) can directly be traced back to the Water Institute**

**Compared to the annual investment made by the University of Waterloo in operating the Water Institute, this implies a Return on Investment (ROI) of 11.1 over 9 years.**

### 3.2 Seed Grants

Since 2011, the Provost has provided additional funding to the Water Institute to provide seed grants to faculty members to stimulate inter-disciplinary collaboration leading to new research proposals and funding. The Water Institute designed, and has since administered its Seed Grants program with the following specific objectives:

- Encourage researchers to collaborate across disciplinary boundaries;
- Catalyze the development of new, inter-disciplinary research teams, or to enhance collaboration in existing teams;
- Encourage inter-institutional, national, and international collaborations;
- Encourage the development of research areas that are new to the University of Waterloo;

- Facilitate the transfer of specialized knowledge and expertise to the University of Waterloo;
- Position research teams for external funding success.

The expectation is that a project supported by seed funding will contribute to an application for external funding within two years.

Since inception in 2011, a total of \$731,000 has funded 43 seed grant projects (Appendix B). A review of 31 projects funded from 2011 to 2017, indicated that the program has been largely successful in meeting its objectives. More specifically, an investment of \$523,000 during this period has resulted in the following “downstream” impacts:

- Trained 41 Highly Qualified Personnel;
- 27 scientific publications;
- 14 innovations;
- \$245,000 in additional funding leveraged;
- >\$5,000,000 in new project funding awarded.

**Compared to the annual investment made by the University of Waterloo in operating the Water Institute Interdisciplinary Seed Grants Program this implies a Return on Investment (ROI) of 9.6 over 7 years.**

### 3.3 Partnership Grants and Contracts

Since 2013-14, the Water Institute has supplemented core funding by obtaining about \$300,000 in partnership grants and contracts. Major sources of funding have included:

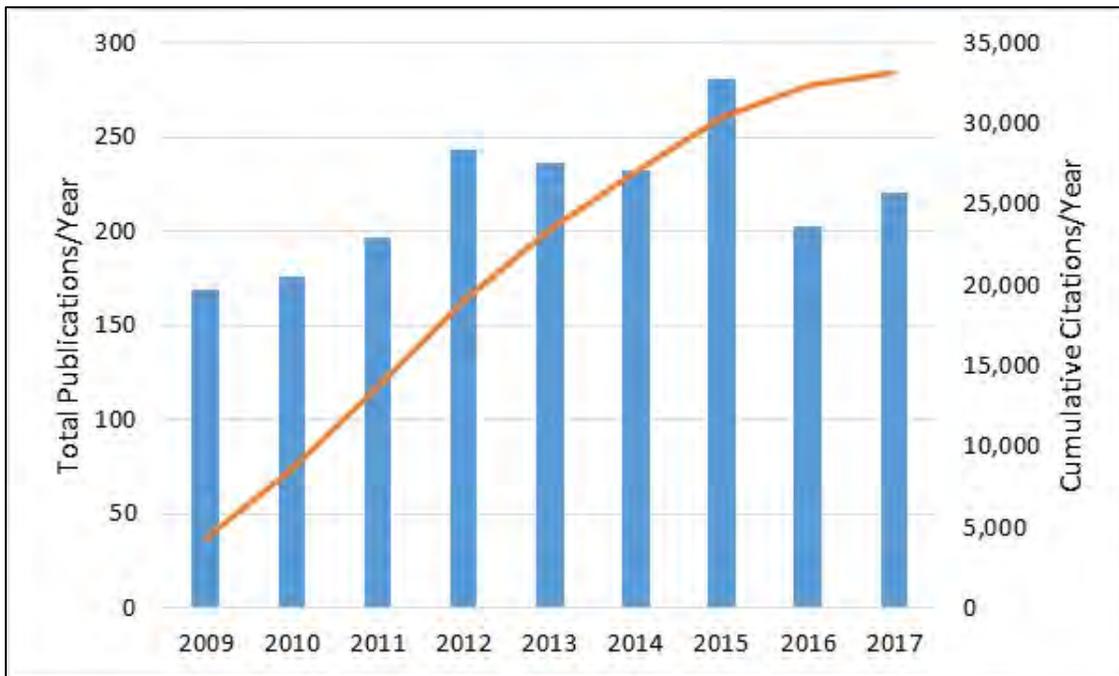
- AquaHacking partnership with the with the de Gaspé Beaubien Foundation (\$140,000);
- Various industry partner grants (\$100,000);
- Waterloo International International Partnership Research Grants (\$45,000);
- Symposia fees (\$15,000).

During World Water Day celebrations on March 22, 2017, the Water Institute and the de Gaspé Beaubien Foundation announced an exciting three-year partnership that combines water expertise and technology to help address the threats facing the Laurentian Great Lakes. More specifically, AquaHacking challenges water scientists, engineers, hackers, and entrepreneurs to develop technologies that address water-related issues, or that take advantage of water-related opportunities through a hacking competition. The partnership brought AquaHacking 2017 – a five-month, Lake Erie-focused hackathon – to Waterloo where Blue Lions Lab – a Waterloo start-up – won the competition. The 2018 event focused on issues facing Lake Ontario and was hosted in Toronto, where a Waterloo startup secured a spot in the finals. The 2019 competition focuses on the entire Great Lakes basin and will be hosted in Montreal. The Water Institute is contracted to provide technical and program advice to the Gaspé Beaubien Foundation, to encourage and support University of Waterloo/Water Institute teams to participate, and to provide event judges.

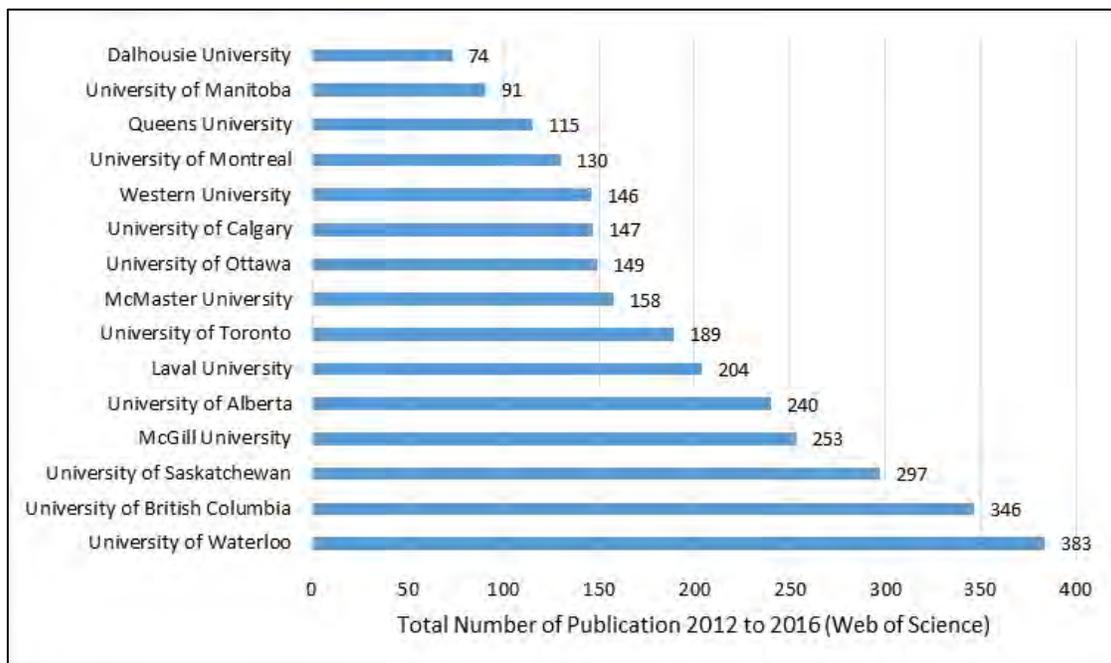
### 3.4 Scholarly Output

Papers published by Water Institute researchers are one indication of the Institute’s size and research output. From 2009 to 2017, Water Institute members have published almost 2,000 papers, and have accrued over 33,000 citations (Figure 6). This equates to an average scholarly output of 218 papers per year. Appendix C lists Water Institute publications during this period. Over the period 2012 to 2016, Water Institute faculty members published more water research articles than any other university in Canada (Figure 7). Note that annual average publication

numbers in Figure 6 and 7 differ significantly due to the use of different search methodologies. While Figure 6 represents a more accurate portrayal of actual publication numbers, Figure 7 compares the Water Institute against other institutions based on the same set of water resources journals.

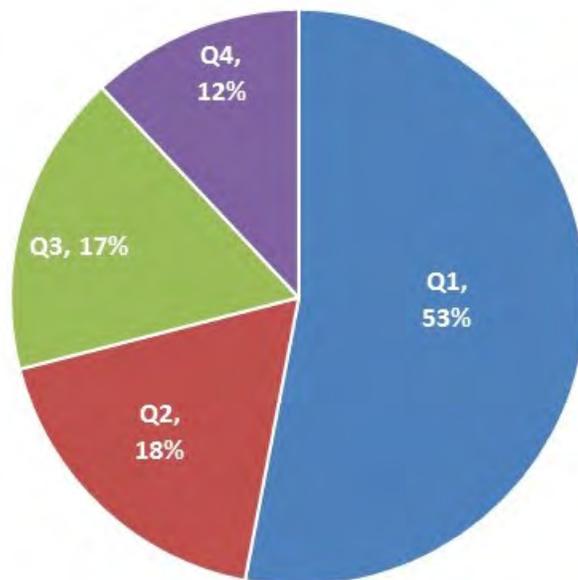


**Figure 6: Total Water Institute Publications and Citations 2009 to 2017**



**Figure 7: Total Publications by Institution 2012 to 2016 (Web of Science, Water Resources journals)**

An important indicator of research excellence is publication in high impact journals. Figure 8 shows the volume of Water Institute publications by journal quartile during the period 2010 to 2017. Over 50% of member publications during this period were in the top quartile of water resources journals identified by the Web of Science ranked by impact factor.



**Figure 8: Percentage of Publications in High Impact Journals 2010 to 2017**  
 (Web of Science, Water Resources journals. Journal quartiles based on journal five-year impact factors)

### 3.5 International Rankings

An independent indication of the Water Institute’s strength and recognition is given in international rankings. While specific ranking schemes for water research organizations are not widespread, several specific schemes have been identified over the past several years. In the 2018 Shanghai Ranking of global universities by academic subject, only Telecommunications Engineering (8) and Hospitality and Tourism (23) programs at the University of Waterloo ranked higher than Water Resources (32). These rankings confirm that not only is water a key strength at the University of Waterloo, it is a recognized international strength.

**32<sup>nd</sup> Best Academic Institution for Water Resources in the World**

Source: Shanghai Ranking of Global Universities, Water Resources, 2018

**10<sup>th</sup> Best Water Research Institution In The World**

Source: Lux Research Inc., Top Academics and Institutions in Water Research 2013

**20<sup>th</sup> Most Prolific Water Research Institute In The World**

Source: Stockholm International Water Institute and Elsevier, The Water and Food Nexus: Trends and Development of the Research Landscape, August 2012.

### 3.6 Research Innovations

Much of the research undertaken by Water Institute members is innovative. Whether new technologies, or new methods or processes are discovered or developed, the research is having an impact in solving particular problems

or in benefitting the environment, economy or society. Table 7 provides examples of some research innovations from Water Institute members.

<b>Member</b>	<b>Research Innovation</b>
William A Anderson, Chemical Engineering	– Developing fast and simple microbial test kit using engineered nanoparticles.
David Blowes, Earth and Environmental Sciences	– Using steel byproduct to remove phosphorus from water
Brian Dixon, Biology	– Developing next generation fish health diagnostic assays and selective breeding techniques to help salmon survive in warming waters.
Christine Dow, Geography and Environmental Management	– Used radar surveys and satellite imagery to discover that ice shelves are being destabilized from enhanced ocean-driven melting at the base, causing large fractures.
Claude Duguay, Geography and Environmental Management	– Developing and testing new sensor technologies for ground-based, airborne, and space-borne use to deliver environmental data from multiple scales.
Monica Emelko, Civil and Environmental Engineering Alexander Wong, Systems Design Engineering	– Developing AI software capable of identifying and quantifying different kinds of cyanobacteria or blue-green algae.
Elizabeth English, Architecture	– Designing buoyant homes that rise and fall with flood water
Peter Huck, Civil and Environmental Engineering	– Improving the performance and robustness of processes to provide safe drinking water.
Laura Hug, Biology	– Updated “Tree of Life” including environmentally-derived genomes from uncultured lineages, clarifying our understanding of the diversity of life on earth.
Juewen Liu, Chemistry	– Developed a number of highly sensitive and selective fluorescent sensors with catalytic DNA to detect contaminants in water.
Josh Neufeld, Biology Sherry Schiff, Earth and Environmental Sciences	– Discovered that millions of lakes in Canada’s Boreal Shield share physico-chemical similarities with the Archean oceans, and can be used as living laboratories for studying ancient oceans, greenhouse gas emissions, and harmful algal blooms.

Carolyn Ren, Mechanical and Mechatronics Engineering	– Developed the first real-time, Intelligent lab-on-chip device for rapid detection of pathogens and contaminants in water.
Heidi Swanson, Biology	– Working side-by-side with local Indigenous fisheries and the Government of Nunavut to implement a restoration plan and train locals in science monitoring techniques that, when combined with their traditional knowledge, can be used to ensure fish remain plentiful into the future.
Michael Tam, Chemical Engineering	– Using cellulose nanomaterials – those derived from wood, plants, algae and bacteria – to make water treatment processes more sustainable.
Philippe Van Cappellen, Earth and Environmental Sciences	– Quantified the global impacts of dams on the flows of carbon and nutrients along river systems, and found that damming significantly alters nutrient limitation patterns, carbon cycling and ecosystem functions in receiving lakes and nearshore marine environments.

### 3.7 Entrepreneurship and Start-ups

Over the past number of years, several Water Institute affiliated faculty members and students have established water-related start-up companies (Table 8). The Water Institute, in some cases, has provided direct support to start-ups (ie, Aquahacking competition, connection to researchers), while - in others - the Institute provided indirect support (eg, promotions).

Table 8: University of Waterloo Water Start-ups	
Company	Description
 <p><b>Blue Lion Labs</b></p>	<p><b>Blue Lion Labs</b></p> <p>Using AI technology and digital imaging to identify and test different types of cyanobacteria. This technology will allow people to be proactive instead of reactive at the onset of an algal bloom by providing valuable data to key decision makers.</p>

**Table 8: University of Waterloo Water Start-ups**

Company	Description
	<p><b>Catalight</b> A social venture with a mission to make safe drinking water accessible for people in developing communities, by providing effective, simple, and low-cost point-of-use water treatment.</p>
	<p><b>EMAGIN</b> Helping water utilities become more efficient and resilient. EMAGIN’s software works with sensors to offer facility operators more accurate and timely information and recommendations. During a storm, for instance, EMAGIN’s software can allow operators to more effectively treat incoming wastewater and prevent overflows.</p>
	<p><b>Oleotech</b> Using oleophilic properties of fiber from waste tires to remove hydrocarbons in stormwater runoff.</p>
	<p><b>PolyGone</b> Tackling microplastic solutions by developing a laundry sheet that catches microplastics in the wash cycle of laundry. “Stop eating your dirty laundry”</p>
<p>Flushing towards a better FUTURE</p> 	<p><b>WaterPuris</b> Tackling the problem of the accumulation of EDC’s in Lake Ontario and surrounding aquatic ecosystems by applying advanced oxidation processes in point-of-entry (laundry, faucets, and toilet) applications. The peroxide that they use, as part of the oxidation process, will react overtime through the sewer system and into the wastewater treatment plant. The hope is that their technology will reduce the chemical and biological oxidation demand so wastewater treatment plants can work optimally.</p>

### 3.8 Collaborative Water Program

A major goal of the Water Institute is to “*promote and support the development of multidisciplinary and interdisciplinary teaching programs*”. In response, an important achievement of the Water Institute is the development and support of the innovative graduate Collaborative Water Program. In a world where interdisciplinary research is of growing importance, the Collaborative Water Program encourages students to push the boundaries of their research and discover innovative ways to tackle global water challenges. Collaborative Water Program students complete their specialist training in their respective home department or school, while working with students from a variety of disciplines in two interdisciplinary courses. These courses capture both theoretical and practical components, including in-class lectures, fieldwork, interdisciplinary group work, and individual research seminars. The objective of the Collaborative Water Program is to provide students with a broad, interdisciplinary foundation in water science, engineering, economics and governance, beyond the specialist training they will continue to receive in their home departments or schools.

**The Water Institute worked closely with University of Waterloo Advancement to secure a substantial gift of \$1.75million over eight years (2013-2020) from the RBC Foundation in support of the Collaborative Water Program. This incremental education funding is being allocated to support:**

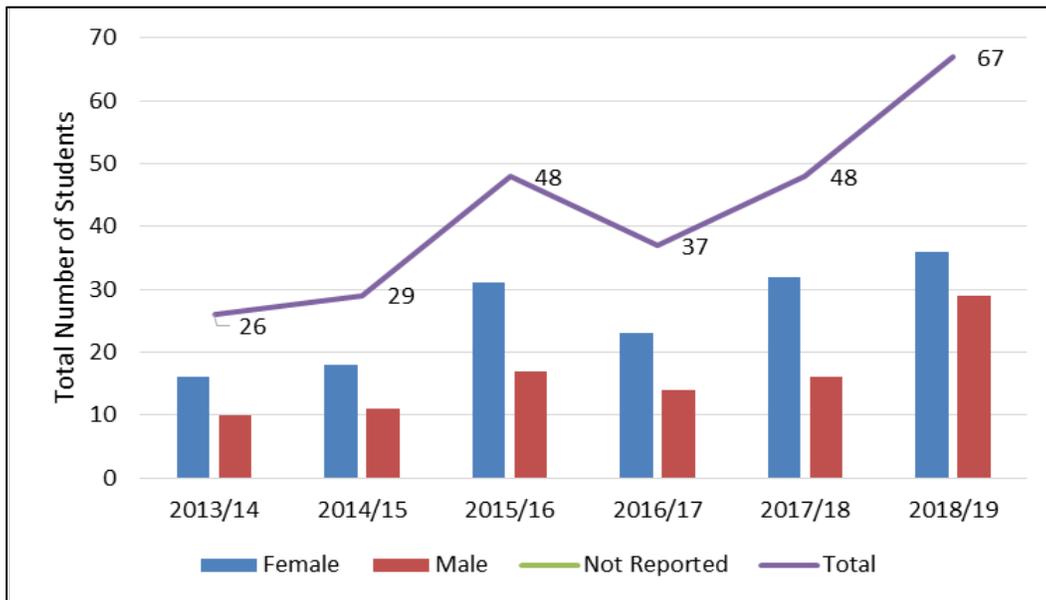
- **Graduate student scholarships (\$900,000);**
- **Course support (\$450,000);**
- **Visiting fellows (\$150,000);**
- **Program development and administration (\$150,000);**
- **Distinguished Lectures (\$100,000).**

After significant consultation and approvals, the Collaborative Water Program was officially launched in the Winter 2014 term. The program consists of two core courses (WATER 601/602) and a research seminar milestone that must be completed in addition to home department/school requirements. The program is open to Masters or PhD students in thesis or major-paper based programs who are studying water. The following eleven departments/schools across all six of Waterloo’s faculties are currently participating in the University of Waterloo’s most interdisciplinary education program:

Faculty	Department/School
Applied Health Sciences	1. Public Health and Health Systems
Arts	2. Economics
Engineering	3. Architecture
	4. Chemical Engineering
	5. Civil and Environmental Engineering
Environment	6. Environment, Resources and Sustainability
	7. Environment, Enterprise and Development
	8. Geography and Environmental Management
Mathematics	9. Applied Mathematics
Science	10. Biology
	11. Earth and Environmental Sciences

The Collaborative Water Program has been a success in terms of enrollment, in meeting program objectives and in student and faculty “satisfaction” surveys. Enrollment in the Collaborative Water Program has increased from 26 students in 2013-14 to 67 students in 2018-19 (Figure 9). Over the first six Collaborative Water Program cohorts (2013-14 to 2018-19), the program has attracted:

- 255 total students;
- 61% female, 38% male and 1% not reporting students;
- 39% Engineering, 30% Science, 26% Environment, 2% Arts, 2% Mathematics and 1% Applied Health Sciences students;
- 75% Masters and 25% PhD students;
- Over 80 Waterloo faculty supervisors with students in the program.



**Figure 9: Collaborative Water Program Enrollment 2013-14 to 2018-19**

Key functions of the Water Institute in supporting the Collaborative Water Program include:

- Maintenance of central records (eg, enrollment, scholarships);
- Support the program Director and Committee;
- Organize program logistics, including classrooms, field trips and orientation sessions;
- Central point of contact for central units, participating departments/schools, students;
- Administer the program budget;
- Support Advancement in donor reporting.

Important benefits of the Collaborative Water Program to the University of Waterloo include:

- Draws together faculty and students from all six academic faculties;
- Provides interdisciplinary education grounded in experiential learning;
- Shaping future water leaders;
- Supports the University of Waterloo’s national and international influence and reputation;
- Builds the University’s brand around graduate research.
- Strengthens and supports the mission of the Water Institute.

In August 2018, the Water Institute administered a survey to over 100 enrolled or graduated Collaborative Water Program students. Students had a favourable attitude towards the program with almost all indicating that the interdisciplinary aspect of the program was one of the reasons they chose to enroll. Specifically students said:

*“Being a student in the Collaborative Water Program, working with students from many other disciplines, has challenged my perspectives and has been a big contributor to my growth as an individual, professional and academic.”*

*“My experience in the Collaborative Water Program has been added to my resume and working in interdisciplinary teams is an important skill that has also been highlighted. I believe this has helped me to secure the position I am in now and has certainly helped me be successful in this new role, as the Collaborative Water Program experience helped to broaden my perspective on issues and logistics related to solving water problems prior to entering the consulting field.”*

*“The Collaborative Water Program helped to illustrate the importance of multidisciplinary teams and forced us look beyond our specializations and comfort zones.”*

*“The amount I’ve learned simply by spending so much time with my peers from such varied disciplines is immeasurable.”*

### 3.9 Student Scholarships

Since 2011-12, the Water Institute has been successful in securing significant funding to provide scholarships to graduate students in various water-related programs.

**Since 2011-12, the Water Institute has provide over 130 graduate student scholarships values at over \$1million. Major funders of Water Institute administered graduate student scholarships have been:**

- RBC Foundation (\$900,000);
- Golder Associates (\$50,000);
- AECOM (\$30,000);
- ARCADIS (\$15,000);
- Stantec (\$15,000).

Appendix D lists Water Institute graduate student scholarship recipients since 2011-12.

### 3.10 Visiting Fellows

The Water Institute has been successful in attracting \$150,000 in funding from the RBC Foundation to support a visiting fellows program. Launched in 2014 and administered by the Water Institute, the purpose of the RBC Visiting Fellows program is to enrich the learning experience of our water students, and to stimulate discussion of collaborative research opportunities with Water Institute faculty members. Fellows are respected national or international water researchers, thought leaders or professionals – with a demonstrated interest in using interdisciplinary approaches to addressing water issues or challenges. Table 9 summaries Water Institute RBC Visiting Fellows since 2014.

**Table 9: Water Institute RBC Visiting Fellows**

Date	Name	Title/Affiliation	Topic Areas
Nov. to Dec. 2014	Nigel Watson	Senior Lecturer, Lancaster University, United Kingdom	water governance and management, integrated catchment management
Jan. 2016	Sharachchandra Lele	Senior Fellow, Ashoka Trust for Research in Ecology and the Environment, Bangalore, India	environmental change, sustainability, interdisciplinary studies in environment and development
Feb. 2016	Priyanka Jamwal	Fellow, Ashoka Trust for Research in Ecology and the Environment, Bangalore, India	contaminant transport in urban hydrological systems, health risk assessment
Mar. 2016	Bejoy Thomas	Fellow, Ashoka Trust for Research in Ecology and the Environment, Bangalore, India	water resources and society
Apr. 2016	Veena Srinivasan	Fellow, Ashoka Trust for Research in Ecology and the Environment, Bangalore, India	inter-sectoral water allocation, threats to freshwater from local to regional to global scales, sustainable water management
Sep. 2016	Pieter van der Zaag	Professor of Integrated Water Resources Management, IHE Delft Institute for Water Education	integrated water resources management, international development
Jan. 2017	Christian Stamm	Deputy Head, Department of Environmental Chemistry, Swiss Federal Institute of Aquatic Science and Technology (Eawag), Switzerland	micropollutants, aquatic ecosystems, interdisciplinary approaches
Sep. 2017	Gunter Blöschl	Head, Institute of Hydrology and Water Resources Management, Vienna University of Technology	hydrology, water resources management
Sep. to Oct. 2017	Arnold Heemink	Professor, Applied Mathematics, TU Delft	data assimilation of large scale water systems and tidal management
Sep. 2018	Nigel Watson	Senior Lecturer, Lancaster University, United Kingdom	water governance and management, integrated catchment management
Sep. to Oct. 2018	William Blomquist	Professor, Department of Political Science, Indiana University School of Liberal Arts at IUPUI	water management, water governance, politics and water

### 3.11 Research Symposia, Conferences and Distinguished Lectures

Since 2013, the Water Institute has successfully organized and hosted four major research symposia and two international conferences that, in total, have attracted over 1,000 participants (Table 10). In addition, during the same period, the Institute has hosted seven distinguished lectures - six supported by the RBC Foundation - that have attracted over 1,300 participants (Table 11). These events have not only raised the profile of the Institute on-campus, and with local, regional and international partners, but have also provided access to leading academics and practitioners to students and faculty.

**Table 10: Water Institute Symposia and International Conferences**

Date	Event	Location	Attendees
May 2, 2013	Research Symposium	University of Waterloo	140
May 1, 2014	Research Symposium	University of Waterloo	165
April 30, 2015	Research Symposium	University of Waterloo	170
April 28, 2016	Research Symposium	University of Waterloo	140
September 10 to 13, 2017	Elsevier International Water Conference: The Role of Water Technology Innovation in the Blue Economy, co-chaired with TU Delft	Crowne Plaza Hotel, Kitchener	±200
September 24, 2018	International Water Conference: Breaking Boundaries in Water Research	University of Waterloo	±200

**Table 11: Water Institute Distinguished Lectures<sup>1</sup>**

Date	Lecturer	Title	Attendees
May 26, 2011	Dr. Tony Allan Professor, King's College, London Stockholm Water Prize Laureate, 2008	Water Security and the Role of Trade	75
May 2, 2013	Professor Asit K. Biswas Distinguished Visiting Professor, Lee Kuan Yew School of Public Policy, Singapore Stockholm Water Prize Laureate, 2006	Future of the World's Water: Rhetoric and Reality?	200
May 1, 2014	Dr. Peter H. Gleick President, Pacific Institute Oakland, California, U.S.A.	The Past, Present, and Future of the World's Water	350
April 30, 2015	Dr. Sunita Narain Director General, Centre for Science and Environment, New Delhi, India	Challenges for Water Security in the Poor's World: The agenda for research and policy to manage water scarcity, plenty, pollution and waste in an age of climate risk	150

**Table 11: Water Institute Distinguished Lectures<sup>1</sup>**

Date	Lecturer	Title	Attendees
April 28, 2016	Dr. Jay Famiglietti Professor, University of California Irvine Senior Water Scientist, California Institute of Technology	Water and Sustainability: 21st Century Realities and the Global Groundwater Crisis	185
September 11, 2017	Dr. Quentin Grafton Professor; Chairholder UNESCO Chair in Water Economics and Transboundary Water Governance; Professor of Economics, Australian National University	Innovation, Incentive and Infrastructure in the Blue Economy	175
September 24, 2018	Dr. Mark van Loosdrecht, Professor, Department of Biotechnology, TU Delft, Delft, The Netherlands Stockholm Water Prize Laureate, 2018	The Future of Water: Innovation, Resource Recovery, and the Blue Economy	200
Note: 1. All lectures, except 2011, were supported by the RBC Foundation and branded as a Water Institute RBC Distinguished Lecture.			

### 3.12 WaterTalks

The Water Institute launched its lecture series (WaterTalks) in March 2010 to promote knowledge and information exchange on water research, and to facilitate interaction between leading water scholars and Institute faculty and student members. To-date, the Water Institute has organized and hosted 94 WaterTalk lectures that have attracted over 3,000 attendees (Appendix E). Many WaterTalks have been recorded and made available on the Water Institute’s YouTube channel where they have been viewed several thousand times.

### 3.13 WaterConnections

In 2018, in collaboration with the Office of Research’s Corporate Research Partnerships team, the Water Institute launched the WaterConnections series to promote engagement between Institute faculty/HQP and external partners. WaterConnections events are generally 60 to 90 minute informal sessions held in the Institute’s boardroom that include a 30 minute presentation by the external partner to introduce their organization and water-related challenges, followed by an informal question/answer period and networking session. The purpose of WaterConnections is to introduce Water Institute members to the issues and challenges that our external partners are facing, to introduce our external partners to Water Institute faculty and HQP, and to catalyze the development of new relationships and potential funding opportunities. To-date, WaterConnections guests have included eleven-x, Canada’s oil Sands Innovation Alliance, Stantec, and Mitacs.

### 3.14 Internationalization

Addressing complex water problems requires the contribution of multiple disciplines and partners. A key strategic goal of the Water Institute, therefore, is to strengthen international networks and partnerships with leading water

organizations and researchers. Figure 10 summarizes key international partnerships of the Water Institute. It should be noted that these are “institutional” level partnerships, and do not reflect the multitude of bilateral partnerships and collaborations undertaken by many Water Institute faculty members. A summary description of several key international partnerships follows.



**Figure 10: Water Institute International Partnerships**

The Water Institute and its faculty members are collaborating with partners in **China** in education and research activities addressing various water security issues. Since 2014, the Water Institute has partnered with the **Chinese Research Academy of Environmental Sciences (CRAES)**, China’s largest environmental research institute, in various joint activities. In 2016-17, the Water Institute Executive Director was appointed to the CRAES International Scientific Advisory Committee, two Water Institute delegations visited CRAES to further joint research programs, and a Waterloo student interned at CRAES. In addition, the Water Institute partnered with **Hohai University** on a new “global change and water cycle” international laboratory, and partnered with **Southwest University** on a new “watershed and lake management” international laboratory and the 2<sup>nd</sup> China-Canada workshop on plateau lakes.

European national research programmes are amongst the finest in the world, but they cannot tackle some of today’s major societal challenges alone. The **European Commission’s (EC) Joint Programming Initiative (JPI)** aims to remedy fragmented research efforts within Europe to address major societal challenges. In 2017-18, the Water Institute partnered with Stockholm University (Sweden), the University of Copenhagen (Denmark), and the University of Coimbra (Portugal) to design and win the EC JPI *Legacies of Agricultural Pollutants (LEAP)* project. As the only international institution included in the Water Challenges for a Changing World JPI, Institute researchers and collaborators will be developing a unified framework that incorporates agricultural legacies and time lags into adaptive management strategies to protect water resources under changing climate and land use.

The Queen Elizabeth Scholars – Advanced Scholars (QES-AS) program is a Canadian initiative that supports doctoral researchers, post-doctoral fellows, and early career researchers from Canada and **Low-and-Middle Income countries (LMICs)** to develop solutions to complex national and global challenges. In 2017-18, the Water Institute won the QES-AS *Water Security as a Foundation for Healthy Communities and Sustainable Livelihoods* project in partnership with McMaster University, the **Kenya Medical Research Institute, Uganda Christian University, University of Zambia** and the **UNDP Global Environment Finance** program in **Pakistan**. The objective of the project, which will train some 30 young researchers, is to increase local water resources management

capacity in support of (i) climate smart agricultural for food security (ii) climate-proof public health services under increasingly severe drought and flood conditions, and (iii) safe water supply and sanitation facilities to improve the health status of mothers and infants.

In 2014, the city of São Paulo nearly ran out of water, while drought, deforestation, and urbanization continue to pressure the state’s water supplies. In 2017/18, a Water Institute delegation was invited by the **Secretariat for the Environment of the State of São Paulo, Brazil** and its research institutes to participate in a three-day workshop to address and discuss the major water challenges facing the state, and the metropolitan area where more than 20 million people live. In 2018/19, the Water Institute will work with the Secretariat to develop a comprehensive, collaborative work plan to investigate priority water security issues to inform water policy and decision-making.

The Water Institute and the **University of Bordeaux/LabEx COTE, France** have been collaborating since 2014, when the Institute convened a workshop in Waterloo with Bordeaux researchers to explore potential areas of collaboration. In 2016, more detailed exploration of respective research programs was the objective when eight Water Institute researchers visited Bordeaux to participate in a follow-up workshop. Outcomes from the workshop included the identification and establishment of several joint Water Institute-Bordeaux/LabExCOTE research clusters, each of which anticipates applying for project funding to initiate new activities. In addition, Water Institute faculty and graduate students were invited to participate in LabExCOTE’s 2017 interdisciplinary summer school on "Weak signals and emerging issues in ecological transition".

The University of Waterloo has collaborated with the **National University of Singapore and the Nanyang Technological University in Singapore** for many years. In mid-2016, the Water Institute participated in the Singapore International Water Week, a premier global platform for various water sector stakeholders to share innovative water solutions. While in Singapore, the Water Institute delegation met water colleagues from the National University of Singapore and the Nanyang Technological University, two highly regarded water research institutions. Discussions included the identification of potential collaboration opportunities in research and education. In October 2016, the Water Institute was pleased to meet with the President of the National University of Singapore during his visit to Waterloo, and in early-2017, to welcome the Executive Director of the Nanyang Environment and Water Research Institute at the Nanyang Technological University to the Water Institute’s External Advisory Board.

In 2014, the University of Waterloo formalized an agreement with **Technion - Israel Institute of Technology** to accelerate joint research and innovation in quantum computing, nanotechnology and water. Prior to the agreement, the Water Institute was kindly invited to visit Technion to explore potential collaboration, and the following year, Waterloo hosted a workshop to explore complimentary research areas in more detail, and to develop funding proposals. These initiatives led to several new joint research projects with Water Institute researchers collaborating with Technion colleagues. These investigations include the use of membranes to remove organic pollutants, and the non-invasive monitoring of the vadose zone.

In addition to research partnerships, the Water Institute administration has represented the Institute at several international water events over the past years (Table 12).

<b>Date</b>	<b>Event</b>	<b>Location</b>
Sep. 2018	IWA World Water Congress	Tokyo
Jun. 2018	International Elsevier Water Security Conference	Toronto

**Table 12: Water Institute Participation in International Events**

Date	Event	Location
Sep. 2017	International Elsevier Water Technology Innovation for the Blue Economy Conference	Waterloo
May 2017	IWA World Water Congress	Mexico
Sep. 2016	World Water Week	Sweden
July 2016	Singapore International Water Week	Singapore

### 3.15 Communications

An important goal for the Water Institute is to raise the profile of water research and education at the University of Waterloo and the Water Institute, and to communicate the impact of our faculty member and student’s research. To this end, the Water Institute produces various communications in print, digital and social media forms to communicate and market our capabilities and impact. In addition, the Water Institute works with, and leverages, the communications expertise and capacity of campus partners from central units, and from faculties, departments and schools. Table 13 summarizes primary Water Institute communications products and channels.

**Table 13: Water Institute Communications Products and Channels**

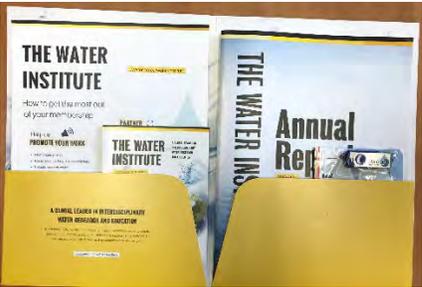
Product/Channel	Description
Website	<p>Home for Water Institute news and stories. Includes general Institute information, membership lists, research themes, projects and impacts, Collaborative Water Program information, events listings and publications.</p> <p><i>Launched in 2016</i></p>
Impact Report	<p>Annual print and digital report that summarizes and provides various Institute information and highlights past year activities, achievements and impacts.</p> <p><i>Seventh annual impact report, first year incorporating digital version with larger reach.</i></p>



**Table 13: Water Institute Communications Products and Channels**

Product/Channel	Description
<p>WaterResearch</p>	<p>Tri-annual print and digital scientific newsletter that provides summaries of new interdisciplinary Water Institute member research papers.</p> <p><i>Launched in 2018, published over 40 articles about water research being conducted by Institute members and collaborators.</i></p> 
<p>WaterNews</p>	<p>Bi-weekly digital newsletter that includes research stories, Institute news and events, new publications and social media highlights.</p> <p><i>Launched in 2016, over 1,200 subscribers.</i></p> 
<p>Brochures</p>	<p>Print and digital publications to promote the Institute or specific programs.</p> 
<p>Videos</p>	<p>Promote and profile the Water Institute and its members.</p> <p><i>Uploaded our Water Institute About Video to YouTube in Sep 2017, over 1,300 views.</i></p> <p><i>Created three videos about Water Institute member research in the Global Water Futures program.</i></p>  <p><a href="#">Watch video on YouTube</a></p>

**Table 13: Water Institute Communications Products and Channels**

Product/Channel	Description
Media	<p>In co-ordination with University Communications, profile members work or provide thought leadership through various media channels.</p> <p><i>2016: 38 news stories</i>  <i>2017: 3 expert advisories, 3 news releases, 79 news stories</i>  <i>2018: 4 expert advisories, 5 news releases, 94 stories</i></p> <p><b>Larry Swatuk comments on the water crisis in Cape Town, South Africa</b></p> <p>THURSDAY, JANUARY 25, 2018</p> <p>Cape Town – a city once at the forefront of Africa’s green movement – has implemented new emergency water restrictions as the sprawling metropolis prepares for the day its taps run dry.</p> <p>Residents are now being asked to curb the amount of municipal water they use each day to just 50 liters (a little over 13 gallons). Only a month ago, level six restrictions had placed residents on a daily allowance of 87 liters (about 23 gallons), illustrating the severity of the looming crisis.</p> <p>Officials estimate that if water levels continue to fall as expected, South Africa’s second most populous city will run out of water by April 16, which has been dubbed “Day Zero.”</p> 
YouTube	<p>Provide on-demand access to WaterTalks and Distinguished Lectures.</p> <p><i>Launched new Water Institute YouTube channel in 2017 with 85 subscribers and over 3,000 views on our videos.</i></p> 
Facebook	<p>Promote and profile Water Institute and activities.</p> <p><i>In two years, we quintupled our followers.</i>  <i>February 2017 = 75 followers</i>  <i>February 2019 = 379 followers</i></p> 
Twitter	<p>Promote and profile Water Institute and partner activities.</p> <p><i>3,607 followers as of February 2018. This is an increase of almost 1,000 since February 2017.</i></p> 
New Member Packages	<p>Welcome new members to the Institute and encourage participation and affiliation.</p> 

## 4. Financials

### 4.1 Water Institute Income and Expenses 2014/15 to 2018/19

The Water Institute was established with a commitment by the Provost to invest \$350,000 per year from 2009-10 through 2013-14 to support its operational budget. This amount was provided each year, except for 2013-14. From 2014-15 to 2018-19, detailed budget requests and justifications were made annually, and the Institute continued to receive an annual \$350,000 operating budget from the Provost. Over the same period, the Water Institute was successful in supplementing the Provost's investment through various grants and contracts with external partners that contributed over \$200,000 in total, or about \$40,000 annually, to its operating budget.

Since 2016-17, the Executive Director has received an annual research stipend (\$30,000) that has been deducted from the Water Institute's operating budget. In summary, therefore, the Water Institute's current annual income is about \$360,000 (\$350,000 + \$40,000 - \$30,000).

Primary Water Institute expense categories are:

- Staff salaries;
- Office expenses;
- Program expenses.

Staff salaries include annual compensation for the Managing Director, Communications Officers, and the Administrative Officer. In addition, since 2016-17, the Executive Director receives an annual salary stipend (\$35,000) in recognition of his contribution to the Institute (0.5 FTE).

From 2015/16 to 2017/18, average annual Water Institute staff salaries were about \$315,000. In 2018/19, the following additional staff salaries were added:

- Communications Officer: 20% of salary from Institute operating account, or an incremental increase of about \$14,000 per year in 2019/20, and 80% of salary from member research projects (see discussion of shared service model below);
- Administrative Officer: return from reduced workload (0.7 FTE) to full-time workload, which is an incremental increase of about \$8,000 per year in 2019/20.

Current salary expenses of the Water Institute are hence about \$337,000 per year (\$315,000 + \$14,000 + \$8,000).

Office expenses include a range of costs directly related to Water Institute operations, including supplies, telephone, printing, computing, equipment purchases, and promotions and advertising. For the period 2014-15 to 2018-19, annual office expenses were about \$44,000.

Program expenses refer to costs, primarily in various travel and hospitality lines, incurred to deliver various interdisciplinary Water Institute research and education activities. Including:

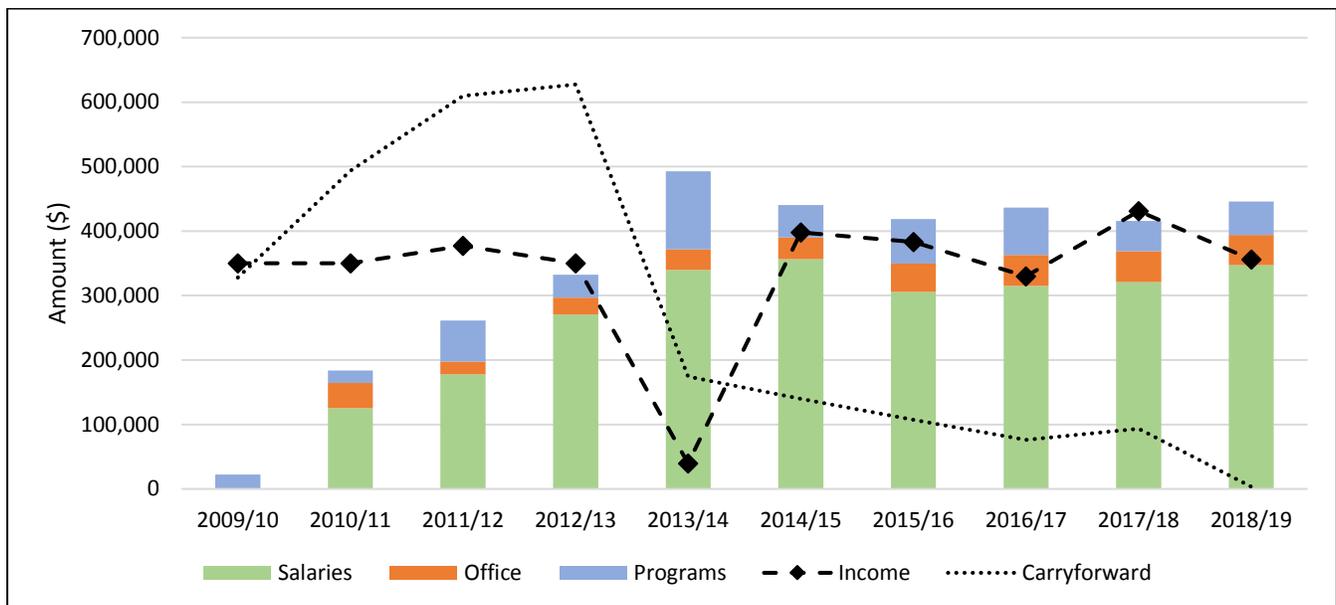
- Supporting the 300+ members and executive of the Water Institute Graduate Students Association (SWIGS);
- Organizing the WaterTalks lecture series;
- Organizing and delivering the annual Water Institute World Water Day event;
- Organizing and executing International Water Institute Scientific Conferences;
- Organizing and delivering Water Institute External Advisory Board Meetings;
- Leading Water Institute delegations on international missions to strategic partner institutions or to major conferences.

Over the period 2014-15 to 2018-19, the average annual Water Institute program costs were about \$58,000.

Table 14 and Figure 11 summarize Water Institute income, expenses, and carryforward budgets or retained earnings for the period 2014-15 to 2018-19. Appendix F includes detailed accounting balance sheets.

<b>Item</b>	<b>2014-15</b>	<b>2015-16</b>	<b>2016-17</b>	<b>2017-18</b>	<b>2018-19</b>
<b>Total Income</b>	<b>398,000</b>	<b>383,000</b>	<b>330,000</b>	<b>431,000</b>	<b>356,000</b>
<i>Salary expenses</i>	356,000	306,000	315,000	321,000	347,000
<i>Office expenses</i>	34,000	44,000	48,000	48,000	47,000
<i>Program expenses</i>	50,000	69,000	74,000	47,000	52,000
<b>Total Expenses</b>	<b>440,000</b>	<b>419,000</b>	<b>437,000</b>	<b>416,000</b>	<b>446,000</b>
<b>Income less Expenses</b>	<b>-42,000</b>	<b>-36,000</b>	<b>-107,000</b>	<b>15,000</b>	<b>-90,000</b>
<i>Carryforward<sup>3</sup></i>	140,000	107,000	76,000	93,000	3,000

Notes  
<sup>1</sup> Financial details can be found in Appendix F.  
<sup>2</sup> Actual income and expenses 2014-15 to 2017-18, forecast income and expenses 2018-19.  
<sup>3</sup> Carryforward amounts taken from Appendix F.



**Figure 11: Income and Expenditures 2009-10 to 2018-19 (2009/10 to 2017/18 actuals, 2018/19 forecast)**

Over the period 2014-15 to 2017-18, the Water Institute has functioned with the following average annual structural deficit in its operating budget:

<b>Total Income</b>	<b>360,000</b>
<i>Salary expenses</i>	<i>330,000</i>
<i>Office expenses</i>	<i>44,000</i>
<i>Program expenses</i>	<i>58,000</i>
<b>Total Expenses</b>	<b>432,000</b>
<b>Income less Expenses</b>	<b>-72,000</b>

The Water Institute's structural deficit includes two significant components: i) the accumulation of annual staff salary increases due to general inflation corrections (ie, Boehmer and Hardy salaries are a combined \$47,000 greater in 2018-19 versus 2011-12), and ii) the \$30,000 research stipend provided to the Executive Director since 2016-17. Neither of these incremental expense increases has been matched by a commensurate increase in the annual budget allocated to the Institute.

As can be seen in Figure 11, the Water Institute's annual deficits over the period 2014-15 to 2018-19 were offset by a carryforward balance that was accumulated by the Institute over its first 4 years of operations, where it underspent against budget. This carryforward balance is, however, forecast to be exhausted at the completion of the current 2018-19 fiscal year (Appendix F).

## 4.2 Proposed Water Institute Budget 2019-20 to 2023-24

As detailed in Section 3, the Water Institute has delivered significant value to its members – faculty and students – and to the University of Waterloo since its inception, and particularly over the past five years. This value has been generated through a University investment of \$350,000 per year. Continued investment at this level, however, will not generate the same value over the upcoming five years as the amount has not kept pace with inflation, and does not represent the current programming of the Institute which was subsidized by carryforward income over the past several years.

Appendix G details potential Water Institute's 2019-20 to 2023-24 budgets under two scenarios:

- Scenario 1: Funding Maintained at Current Level (\$350,000 per year);
- Scenario 2: Programming Maintained at Current Level.

Both budget scenarios include the following assumptions:

- The Institute will secure additional income in the amount of \$50,000 per year from various grants and contracts to supplement operating funds;
- That a \$30,000 Executive Director research stipend will be deducted from operating funds
- No new headcount will be added during the period;
- Annual salary increase of 3% due to general inflation<sup>1</sup>;
- No increase to the Executive Director salary stipend (\$35,000 per year);
- Annual office expense increase of 3% due to general inflation.

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<sup>1</sup> Inflation in Ontario for all products and services (CPI) was 2.3% in 2016 compared to 2015, 2.2% in 2017 compared to 2016 and 3.1% in 2018 compared to 2017 (Statistics Canada, [www150.statcan.gc.ca](http://www150.statcan.gc.ca)).

Both budget scenarios consider that the following Water Institute programming will be delivered during the period 2019-20 to 2023-24:

<u>Program</u>	<u>Frequency</u>
Water Institute Graduate Students Association (SWIGS)	annual
WaterTalks lecture series	annual
Water Institute World Water Day event	annual
Water Institute International Outreach and Partnerships	annual
Water Institute Scientific Interdisciplinary Conference/Symposia	bi-annual
Water Institute Scientific External Advisory Board Meeting	bi-annual
Water Institute Interdisciplinary PhD Summer School	bi-annual

Program costs were derived by calculating total costs to deliver the specified programming above over the 5-year period, then assuming average annual costs per expense line 2019-20. A 3% increase per year was applied to program costs in subsequent years to factor in general inflation.

Table 15 summarizes projected Water Institute financials for the period 2019-20 to 2023-24 assuming that the annual operating investment of the University is maintained at \$350,000 (Scenario 1). As shown in Table 15, funding at this level will only cover salary and (partial) office expenses in early years, and will be totally consumed by salaries by year 5. No Water Institute programming will be possible in any year under this scenario.

<b>Table 15: Funding Maintained at Current Level (Scenario 1)</b>					
<b>Item</b>	<b>2019-20</b>	<b>2020-21</b>	<b>2021-22</b>	<b>2022-23</b>	<b>2023-24</b>
<b>Total Income</b>	<b>370,000</b>	<b>370,000</b>	<b>370,000</b>	<b>370,000</b>	<b>370,000</b>
<i>Salary expenses</i>	338,000	346,000	355,000	365,000	375,000
<i>Office expenses</i>	45,000	46,000	48,000	49,000	50,000
<i>Program expenses</i>	63,000	65,000	67,000	69,000	71,000
<b>Total Expenses</b>	<b>446,000</b>	<b>457,000</b>	<b>470,000</b>	<b>483,000</b>	<b>496,000</b>
<b>Income less Expenses</b>	<b>-76,000</b>	<b>-87,000</b>	<b>-100,000</b>	<b>-113,000</b>	<b>-126,000</b>
<i>Carryforward</i>	<i>-76,000</i>	<i>-163,000</i>	<i>-263,000</i>	<i>-376,000</i>	<i>-502,000</i>
Notes					
<sup>1</sup> Budget details can be found in Appendix G.					

Table 16 summarizes projected Water Institute financials for the period 2019-20 to 2023-24 assuming that the current level and quality of Water Institute programming is maintained (Scenario 2). As shown in Table 16, an increase of \$100,000 per year to the Water Institute’s operating budget – from \$350,000 to \$450,000 – will allow the Institute to maintain its programming and value to members under the current institutional structure.

**Table 16: Programming Maintained at Current Level (Scenario 2)<sup>1</sup>**

Item	2019-20	2020-21	2021-22	2022-23	2023-24
<b>Total Income</b>	<b>470,000</b>	<b>470,000</b>	<b>470,000</b>	<b>470,000</b>	<b>470,000</b>
<i>Salary expenses</i>	338,000	346,000	355,000	365,000	374,000
<i>Office expenses</i>	45,000	46,000	47,000	49,000	50,000
<i>Program expenses</i>	63,000	65,000	67,000	69,000	71,000
<b>Total Expenses</b>	<b>446,000</b>	<b>457,000</b>	<b>469,000</b>	<b>483,000</b>	<b>495,000</b>
<b>Income less Expenses</b>	<b>24,000</b>	<b>13,000</b>	<b>1,000</b>	<b>-13,000</b>	<b>-25,000</b>
<i>Carryforward</i>	24,000	37,000	38,000	25,000	0
Notes					
<sup>1</sup> Budget details can be found in Appendix G.					

### 4.3 Water Institute Seed Grants Program

Since 2014-15, the Provost has invested \$750,000 in the Water Institute’s interdisciplinary Seed Grants program. This investment is independent of the Institute’s operating budget, and is 100% earmarked for the program. Section 3.2 detailed the objectives and impact of the Seed Grants Program. A review of 31 projects funded from 2011 to 2017, indicated that the program has been very successful in meeting its objectives. The investment of \$523,000 during this period has resulting in the following “downstream” impacts:

- Training of 41 Highly Qualified Personnel;
- 27 high impact scientific publications;
- 14 innovations;
- \$245,000 in additional funding leveraged;
- >\$5,000,000 in new project funding awarded.

Based on the outcomes of a recent online survey among all Water Institute members and 30 in-depth interviews with key Water Institute faculty in 13 different departments across all 6 faculties, Water Institute faculty members indicate that they place great value on the Seed Grants program, and in its ability to catalyze new interdisciplinary teams and collaborations. The Institute therefore respectfully requests that the current seed grant funding level of \$150,000 per year be maintained for the period 2019-20 to 2023-24.

### 4.4 Water Institute Shared Services

In 2017-18, the Water Institute implemented an innovative “shared services” business model, where specific services delivered by Institute staff were paid for by Water Institute members through their research projects. More specifically, the Water Institute’s Knowledge Mobilization Specialist position has been 100% funded from research projects since 2017-18, with a commitment through 2023-24. In 2018-19, the Institute added a second Communications Officer position, funded 60% through faculty member research projects, 20% from a Water Institute trust account, and 20% from the Institute’s operating budget, with multiple year shared service commitments. While working with Principal Investigators and supporting specific projects, these staff remain under the management and administration of the Water Institute. The shared serviced model currently contributes about \$120,000 per year to offset Water Institute staff salaries, and is a true indication of the value our members place in these centralized, shared services.

During the period 2019-20 to 2023-24, the Water Institute intends to consolidate and, where possible, expand its shared service offering. More specifically, the Institute plans to offer, in addition to Knowledge Mobilization and Communications, Project Management services. These services are considered of very high value and in high demand by our members as the Institute has the critical capacity to provide tailored cross-faculty project management and accounting services, where the Institute maintains responsibility for staff management, office space, and overhead expenses. This model is also consistent with current trends and expectations that requirements to integrate Knowledge Mobilization and Communications components into research proposals and projects will become more and more prevalent over the coming years in Canadian research programs.

## 5. Strategic Directions

### 5.1 Progress Against the Current Strategic Plan (2014 to 2019)

In mid-2013, the Water Institute initiated its first formal strategic planning process which resulted in the 2014 to 2019 strategic plan. That plan revised the Institute's vision and mission, and detailed specific goals and objectives in the priority areas of research and education, and the supporting area of branding. Table 17 summarizes progress against the 2014 to 2019 strategic plan.

<b>Table 17: Status of 2014 to 2019 Strategic Plan Goals and Objectives</b>	
<b>Area / Goal / Objective</b>	<b>Status</b>
<b>Research, Strategic Goal 1: Promote and support relevant, collaborative, interdisciplinary water research.</b>	
1.1 Focus and differentiate by identifying research themes where interdisciplinary collaboration is of significant interest to Water Institute researchers, external partners and stakeholders.	Achieved
1.2 Promote the development of interdisciplinary research projects in theme areas by catalyzing the development of research networks and teams and providing assistance in identifying and securing research funding.	Achieving
1.3 Strengthen interdisciplinary research and teaching capacity by supporting the University, Faculties and Departments in recruiting high-profile intermediate or senior water faculty in key areas.	Achieving
1.4 Support interdisciplinary research and teaching capacity by establishing a Water Institute Fellows program.	Achieved
1.5 Promote knowledge transfer through strengthening of the Water Institute seminar series.	Achieved
1.6 Increase the profile and impact of Water Institute research through the active communication of research outcomes across a range of audiences.	Achieving
<b>Research, Strategic Goal 2: Strengthen global networks and partnerships with leading water organizations and researchers.</b>	
2.1 Strengthen and expand collaboration with the private sector, government, civil society and other external stakeholders by building relationships and identifying collaborative opportunities.	Achieving
2.2 Lead or participate in global research networks by developing and implementing partnerships with respected national and international water researchers and organizations.	Achieving
2.3 Enrich external guidance by increasing the diversity of the Water Institute's External Advisory Board.	Achieved
2.4 Strengthen relationships with other University of Waterloo-based water-related centres and institutes by identifying opportunities to support or to collaborate.	Achieving
<b>Education and Training, Strategic Goal 3: Promote interdisciplinary perspectives in water-related education.</b>	
3.1 Ensure the success and sustainability of the collaborative water graduate program by providing co-ordination and support, implementing a review process to identify opportunities for improvement, and identifying and addressing ongoing resource needs.	Achieving

**Table 17: Status of 2014 to 2019 Strategic Plan Goals and Objectives**

Area / Goal / Objective	Status
3.2 Expand interdisciplinary education by identifying opportunities at the undergraduate and graduate levels.	Achieving
3.3 Promote knowledge transfer through strengthening of the Water Institute seminar series ( <i>also supports Strategic Goal 1, see objective 1.6</i> ).	Achieved
3.4 Support interdisciplinary research and teaching capacity by establishing a Water Institute Fellows program ( <i>also supports Strategic Goal 1, see objective 1.4</i> ).	Achieved
<b>Education and Training, Strategic Goal 4: Strengthen the capacity of water resources professionals.</b>	
4.1 Assess domestic and international market needs for training, including short courses, distance education or on-line courses, through discussions with external partners and stakeholders.	Achieving
4.2 Define potential Water Institute training offerings by aligning faculty interests and capacities with identified needs.	Achieving
4.3 Promote Water Institute training capabilities, and facilitate the delivery of training or professional development activities.	Achieving
<b>Brand, Strategic Goal 5: Increase the Water Institute's profile.</b>	
5.1 Facilitate collaboration and improve visibility by working with the University administration to secure a new physical space for the Water Institute ( <i>also supports Research and Education and Training goals</i> ).	Achieved
5.2 Increase the Water Institute's internal and external visibility and recognition by developing and implementing a marketing and communications plan, including consideration of the target audience(s), objectives, messaging and vehicles (eg, web, print, social media, trade shows, advertising, media releases).	Achieved
5.3 Increase engagement with the local community by developing and implementing a community outreach program, including consideration of a public event series.	Not achieved
5.4 Increase profile with external stakeholders and the media by regularly providing perspectives or opinion on water-related matters.	Achieving
5.5 Ensure alignment and cooperation by working with University of Waterloo Faculties and Departments, and administrative offices such as Advancement, Communications and Public Affairs and Waterloo International.	Achieved
5.6 Support faculty participation by identifying incentives (eg, seed funding, positions) and addressing disincentives (eg, departmental recognition) to involvement in the Water Institute.	Achieved
5.7 Increase recognition and profile by acknowledging the achievements of faculty and students, and facilitating opportunities for faculty and students to be affiliated with the Water Institute (eg, publications, presentations).	Achieving
5.8 Increase profile and recognition with international experts by hosting at least one global conference or summit.	Achieved

## 5.2 Strategic Plan Directions (2020 to 2025)

The Water Institute is currently renewing its strategic plan. As in 2013, a bottom-up, participatory process has been designed to ensure faculty members have the opportunity to reflect on past achievements and challenges, and to identify strategic directions and priorities for the future. Key inputs into the Water Institute’s 2020 to 2025 strategic plan include:

- Water Institute benchmarking study (under development);
- Faculty survey (complete, n= 28, results in Appendix H);
- Dean interviews (n=5);
- Faculty interviews ( n=25);
- Faculty focus groups (forthcoming);
- Strategic Planning Committee retreat (forthcoming).

Based on the above inputs, the Water Institute administration will work jointly with the Strategic Planning Committee to develop strategic priorities, goals and objectives for the period 2020 to 2025. Based on preliminary findings, the overriding goal for the Water Institute over upcoming years will be to further increase our impact. The 2020 to 2025 strategic plan will thus detail specific (sub)goals, objectives, and activities to increase the Water Institute’s impact and significance in key areas such as research, education, innovation, communications, and service delivery. Potential 2020 to 2025 strategic goals and activities are listed in Table 18.

<b>Goals</b>	<b>Potential Activities</b>
Increase research impact	<ul style="list-style-type: none"> <li>– Design and implement an interdisciplinary research program with specific research tracks in areas of competitive advantage.</li> <li>– Facilitate the development of new interdisciplinary research teams through activities such as targeted meetings or workshops.</li> <li>– Proactively identify potential funding sources and develop project proposals in research track areas.</li> <li>– Explore the development of a Water Institute post-doctoral researcher program in research track areas.</li> <li>– Manage and administer interdisciplinary research programs and projects through the Water Institute.</li> <li>– Work with the Office of Research, Faculties, and Departments/Schools to inform hiring of water chairs/professors in priority areas.</li> </ul>
Increase academic rankings	<ul style="list-style-type: none"> <li>– Develop and implement a strategy to improve Waterloo’s position in academic rankings specific to water, including bibliometric and other relevant measures.</li> <li>– Encourage faculty members to affiliate with the Water Institute in publications, communications, and internal project reporting systems.</li> </ul>
Increase innovation impact	<ul style="list-style-type: none"> <li>– Design and organize student innovation competition.</li> <li>– Identify and profile faculty member innovations.</li> </ul>
Increase internationalization impact	<ul style="list-style-type: none"> <li>– Focus internationalization activities with a limited number of strategic partners.</li> </ul>

**Table 18: Potential Strategic Directions 2020 to 2025**

Goals	Potential Activities
	<ul style="list-style-type: none"> <li>– Organize an annual international interdisciplinary summer school.</li> </ul>
Increase education impact	<ul style="list-style-type: none"> <li>– Lead implementation of the “post-RBC” Collaborative Water Program business model.</li> </ul>
Increase stakeholder engagement	<ul style="list-style-type: none"> <li>– Design and implement activities to engage science users with researchers and students, for example workshops or symposia.</li> <li>– Organize regular WaterConnections events to facilitate the development of researcher, student, and stakeholder relationships.</li> <li>– Develop opportunities for industry to sponsor Water Institute activities such as conferences or innovation competitions.</li> </ul>
Increase local outreach	<ul style="list-style-type: none"> <li>– Organize regular community events such as lectures or roundtables.</li> <li>– Work with graduate students section to explore education or outreach initiatives with local schools.</li> </ul>
Improve service delivery	<ul style="list-style-type: none"> <li>– Communicate and expand the shared service model to provide members with knowledge mobilization, communications, project management, and business development/proposal writing services.</li> <li>– Develop and implement capacity building activities for Water Institute Highly Qualified Personnel.</li> <li>– Explore opportunities to acquire or facilitate access to shared infrastructure (eg, labs) among members.</li> <li>– Work with Waterloo Advancement to develop a Water Institute fundraising strategy.</li> <li>– Work with partners (eg, CWN, SOWC) to develop a “Waterloo Water Hub” strategy and promotions.</li> </ul>

## Appendix A: Faculty Membership

### Faculty of Applied Health Sciences

Bryan Grimwood, Recreation & Leisure Studies  
Craig Janes, Public Health & Health Systems  
Brian Laird, Public Health & Health Systems  
Jane Law, Public Health & Health Systems  
Shannon Majowicz, Public Health & Health Systems  
Kelly Skinner, Public Health & Health Systems

### Faculty of Arts

Neil Brisley, Accounting & Finance  
Roy Brouwer, Economics  
Heather Douglas, Philosophy  
Daniel Henstra, Political Science  
Margaret Insley, Economics  
Alain-Désiré Nimubona, Economics  
Horatiu Rus, Economics; Political Science

### Faculty of Engineering

William A. Anderson, Chemical Engineering  
William B. Anderson, Civil & Environmental Engineering  
William Annable, Civil & Environmental Engineering  
Nandita Basu, Civil & Environmental Engineering  
Donald Burn, Civil & Environmental Engineering  
Giovanni Cascante, Civil & Environmental Engineering  
John Chatzis, Chemical Engineering  
Pu Chen, Chemical Engineering  
Zhongwei Chen, Chemical Engineering  
David Clausi, Systems Design Engineering  
James Craig, Civil & Environmental Engineering  
Monica Emelko, Civil & Environmental Engineering  
Elizabeth English, Architecture  
Xianshe Feng, Chemical Engineering  
Robert Gracie, Civil & Environmental Engineering  
Frank Gu, Chemical Engineering  
Keith Hipel, Systems Design Engineering  
Marios Ioannidis, Chemical Engineering  
Shesha Jayaram, Electrical & Computer Engineering  
Chao Jin, Systems Design Engineering  
Mark Knight, Civil & Environmental Engineering  
Hyung-Sool Lee, Civil & Environmental Engineering  
Raymond Legge, Chemical Engineering  
Dongqing Li, Mechanical & Mechatronics Engineering  
Bruce MacVicar, Civil & Environmental Engineering  
Robert McKillop, Civil & Environmental Engineering  
Christine Moresoli, Chemical Engineering  
Stefano Normani, Civil & Environmental Engineering  
Wayne Parker, Civil & Environmental Engineering  
Sigrid Peldszus, Civil & Environmental Engineering  
Kumaraswamy Ponnambalam, Systems Design Engineering  
Mark Pritzker, Chemical Engineering  
Carolyn Ren, Mechanical & Mechatronics Engineering  
Simarjeet Saini, Electrical & Computer Engineering  
Armaghan Salehian, Mechanical & Mechatronics Engineering  
Andrea Scott, Systems Design Engineering  
Yuri Shardt, Chemical Engineering  
Jonathan Sykes, Civil & Environmental Engineering

Michael Tam, Chemical Engineering  
Neil Thomson, Civil & Environmental Engineering  
Bryan Tolson, Civil & Environmental Engineering  
Michele Van Dyke, Civil & Environmental Engineering  
Alexander Wong, Systems Design Engineering  
John Yeow, Systems Design Engineering  
Youngki Yoon, Electrical & Computer Engineering  
Aiping Yu, Chemical Engineering  
Norman Zhou, Mechanical & Mechatronics Engineering

### Faculty of Environment

Derek Armitage, Environment, Resources & Sustainability  
Simon Courtenay, Environment, Resources & Sustainability  
Rob de Loë, Environment, Resources & Sustainability  
Peter Deadman, Geography & Environmental Management  
Brent Doberstein, Geography & Environmental Management  
Christine Dow, Geography & Environmental Management  
Claude Duguay, Geography & Environmental Management  
Susan Elliott, Geography & Environmental Management  
Blair Feltmate, Environment, Enterprise & Development  
Chris Fletcher, Geography & Environmental Management  
Thomas Homer-Dixon, Environment, Enterprise & Development  
Peter Johnson, Geography & Environmental Management  
Richard Kelly, Geography & Environmental Management  
Brendon Larson, Environment, Resources & Sustainability  
Jane Law, Planning  
Ellsworth LeDrew, Geography & Environmental Management  
Jonathan Li, Geography & Environmental Management  
Merrin Macrae, Geography & Environmental Management  
Bruce Mitchell, Geography & Environmental Management  
Carrie Mitchell, Planning  
Stephen Murphy, Environment, Resources & Sustainability  
Prateep Nayak, Environment, Enterprise & Development  
Maren Oelbermann, Environment, Resources & Sustainability  
Richard Petrone, Geography & Environmental Management  
Jeremy Pittman, Planning  
Jonathan Price, Geography & Environmental Management  
Derek Robinson, Geography & Environmental Management  
Daniel Scott, Geography & Environmental Management  
Simron Singh, Environment, Enterprise & Development  
Michael Stone, Geography & Environmental Management  
Maria Strack, Geography & Environmental Management  
Larry Swatuk, Environment, Enterprise & Development  
Johanna W&el, Geography & Environmental Management  
Olaf Weber, Environment, Enterprise & Development  
Sarah Wolfe, Environment Resources & Sustainability  
Michael Wood, Environment, Enterprise & Development

### Faculty of Mathematics

Paulo Alencar, Computer Science  
Gladimir Baranoski, Computer Science  
Don Cowan, Computer Science  
Serge D'Alessio, Applied Mathematics  
Peter Forsyth, Computer Science  
Kevin Lamb, Applied Mathematics  
Francis Poulin, Applied Mathematics

Marek Stastna, Applied Mathematics  
Ken Seng Tan, Statistics & Actuarial Science  
Michael Waite, Applied Mathematics

**Faculty of Science**

Nandita Basu, Earth & Environmental Sciences  
David Blowes, Earth & Environmental Sciences  
Niels Bols, Biology  
Barbara Butler, Biology  
Trevor Charles, Biology  
Brewster Conant, Earth & Environmental Sciences  
Paul Craig, Biology  
Brian Dixon, Biology  
George Dixon, Biology  
Hans Dürr, Earth & Environmental Sciences  
Maurice Dusseault, Earth & Environmental Sciences  
Tony Endres, Earth & Environmental Sciences  
Stephen Evans, Earth & Environmental Sciences  
Shaun Frape, Earth & Environmental Sciences  
Emil Frind, Earth & Environmental Sciences  
Bob Gillham, Earth & Environmental Sciences  
Tadeusz Górecki, Chemistry  
Bruce Greenberg, Biology  
Roland Hall, Biology  
John Heikkila, Biology  
John Honek, Chemistry  
Peter Huck, Civil & Environmental Engineering  
Laura Hug, Biology  
Walter Illman, Earth & Environmental Sciences  
John Johnston, Earth & Environmental Sciences

Vassili Karanassios, Chemistry  
Barb Katzenback, Biology  
Tong Leung, Chemistry  
Juewen Liu, Chemistry  
Kirsten Müller, Biology  
Josh Neufeld, Biology  
Chris Parsons, Earth & Environmental Sciences  
Janusz Pawliszyn, Chemistry  
Thai Phan, Earth & Environmental Sciences  
Michael Power, Biology  
Carol Ptacek, Earth & Environmental Sciences  
Fereidoun Rezanezhad, Earth & Environmental Sciences  
Rebecca Rooney, Biology  
Martin Ross, Earth & Environmental Sciences  
David Rudolph, Earth & Environmental Sciences  
Sherry Schiff, Earth & Environmental Sciences  
Mark Servos, Biology  
Ralph Smith, Biology  
David Spafford, Biology  
Edward Sudicky, Earth & Environmental Sciences  
Heidi Swanson, Biology  
Shirley Tang, Chemistry  
William Taylor, Biology  
André Unger, Earth & Environmental Sciences  
Philippe Van Cappellen, Earth & Environmental Sciences  
Barry Warner, Earth & Environmental Sciences  
Jonathan Witt, Biology

**Renison University College**

Robert Case, Social Development Studies

## Appendix B: Seed Grant Recipients

Year	Recipient Department/School	Topic	Grant (\$)
2011/12	Christine Moresoli Chemical Engineering	Opportunities for Research Partnerships in Membrane-based Water Treatment Applications	6,276
2011/12	Stephen Murphy Environment and Resource Studies	Innovations in Water Source Protection, Protected Areas and Ecosystem Resilience	11,128
2011/12	Larry Swatuk Environment, Enterprise and Development	Governing Wetlands and Watersheds: Issues, Cases, Practices	13,100
2011/12	Sheree Pagsuyoyn Civil and Environmental Engineering	Complex Systems and Agent Based Modeling: Applications in Integrated Management of Water Systems	8,966
2011/12	Derek Armitage Environment and Resource Studies	Resolving Science-Policy Gaps in Transboundary Water Governance	15,000
2012/13	Sarah Wolfe Environment and Resource Studies	Thinking about Water: What, why and how we teach to engage the next generation of interdisciplinary water leaders	15,000
2012/13	Susan Elliott Public Health and Health Systems	Water for Wellbeing in Marginalized Communities	14,860
2012/13	Larry Swatuk Environment, Enterprise and Development	Healthy Climates: Governance in the Water, Energy, Food and Climate Security Nexus	15,000
2013/14	Carrie Mitchell/Johanna Wandel Planning/ Geography and Environmental Management	How are we adapting to the water-related impacts of climate change?	15,000
2013/14	Hans Dürr Earth and Environmental Sciences	The Grand River Watershed: From Science to Smart Water Management	15,000
2014/15	Fereidoun Rezanezhad Earth and Environmental Sciences	Capacity building in hydrobiogeophysics (HBGP) at the University of Waterloo	12,000
2014/15	Nandita Basu Earth and Environmental Sciences Civil and Environmental Engineering	Monsoon Harvests in rapidly changing landscapes: Understanding the role of the ancient tank irrigation systems in increasing climate change adaptability	20,000
2014/15	Susan Elliott Geography and Environmental Management	Empowering women through WaSH across the lifecourse	13,375
2014/15	Stephen Murphy Environment and Resource Studies	Comparative indicators of socio-ecological resilience and restoration of aquatic ecosystems	12,000
2014/15	Josh Neufeld Biology	Microbiology of Archaean ocean analogues within the Experimental Lakes Area: Implications for cyanobacterial blooms, mercury cycling, and beyond!	20,000
2014/15	Jonathan Price Geography and Environmental Management	Incorporating wetlands for water management in reclamation of post-mined landscapes	19,500
2015/16	Larry Swatuk Environment, Enterprise and Development	Boomerang Effect: Climate Change Adaptation, Organized Violence and Regional (In)Security	20,000

Year	Recipient Department/School	Topic	Grant (\$)
2015/16	Philippe Van Cappellen Earth and Environmental Sciences	Do watershed biogeochemical models really inform coastal ecology and environmental policy? Assessing knowledge gaps and charting the way forward in linking hydrology, biogeochemistry and land use to coastal ecosystem functions and environmental impacts	14,648
2015/16	Elijah Bisung / Susan Elliott Geography and Environmental Management	Public perception and priorities for safe water in Accra, Ghana	17,660
2015/16	Craig Janes Public Health and Health Systems	Implementing an open access GIS and satellite imaging system to inform health system spatial planning in Western District, Zambia	19,000
2015/16	John Johnston Earth and Environmental Science	Establishment of the first and most detailed account of lake-levels in the Peace-Athabasca Delta: A key hydrologic node of the Mackenzie River Basin, northwestern Canada	20,000
2015/16	Homa Kheyrollah Pour Geography and Environmental Management	Improving weather forecasting models with satellite data assimilation: A new initiative at University of Waterloo	18,000
2015/16	Prateep Nayak Environment, Enterprise and Development	Catching ripples in the water: A social-ecological regime shifts approach to understand abrupt changes in coastal watersheds and crafting governance arrangements	19,995
2015/16	Philippe Van Cappellen Earth and Environmental Sciences	Reactive interfaces in agroecosystems: Meta-analysis and uncertainty analysis of biogeochemical functions in agricultural landscapes	17,507
2016/17	Bruce MacVicar Civil and Environmental Engineering	Linking stream network process models to robust adaptive data management systems for the development of decision support tools that model cumulative effects in watersheds	11,200
2016/17	Chris Parsons Earth and Environmental Sciences	Nutrient cycling and contaminant transport in groundwater of Southern Ontario (Canada) and Quintana Roo (Mexico): Similarities, differences, collaboration and solutions	11,300
2016/17	Philippe Van Cappellen Earth and Environmental Sciences	What do current water quality monitoring programs really tell us, and how can we improve them? Assessing water quality monitoring programs with the aim of improving Ontario's provincial Water Quality Monitoring Network	20,000
2016/17	Rebecca Rooney Biology	Interdisciplinary assessment of whether intervention is warranted in the management of aquatic invasive species	11,746
2016/17	Simron Singh Environment, Enterprise and Development	Governance, institutions and water metabolism: Developing an operational framework for the Caribbean	19,640
2016/17	Pu Chen Chemical Engineering	Polymer/graphene nanocomposite membranes to enhance demineralization of waste water	20,000

Year	Recipient Department/School	Topic	Grant (\$)
2016/17	Peter Deadman Geography and Environmental Management	Integrated assessment of agricultural best management practices and phosphorus runoff	20,000
2016/17	Elizabeth English Architecture	International symposium on the development of government, insurance and building code policies to support innovation in flood damage reduction	19,680
2016/17	Mahyar Shafi Earth and Environmental Sciences	Stormwater management and nutrients control in extreme events: Mobilization of knowledge on the reduction of nutrient loading from urban non-point sources under climate change	16,000
2017/18	Laura Hug Biology	Towards statistical tools to assess microbial communities in contaminated water systems	20,000
2017/18	Christina Smeaton Earth and Environmental Sciences	Linking Microbial Bioenergetics and Water Resources: Turning Theoretical Advances into Practical Solutions	13,992
2017/18	Michael Wood Environment, Enterprise and Development	Fostering Canada's Blue Economy through Provincial and National Bulk Water Pricing Strategies	18,700
2017/18	Susan Elliott Geography and Environmental Management	WASH for resilient health systems in the Horn of Africa	20,000
2017/18	Roy Brouwer Economics	Informing investment decisions in Canada in drinking water and wastewater treatment technology to reduce environmental and human health risks of micropollutants	20,000
2017/18	Chris Fletcher Geography and Environmental Management	Toward actionable science to predict snow and water availability in a changing climate	18,708
2017/18	Homa Kheyrollah Pour Earth and Environmental Sciences	Seasonal patterns of chlorophyll and temperature in lakes: Detection and attribution of climate change signal	14,900
2017/18	Geertje Pronk Earth and Environmental Sciences	Upscaling approaches in watershed biogeochemical modelling	15,000
2018/19	Maurice Dusseault Earth and Environmental Sciences	Migration of "sulphur water" discharge to streams from the Dundee-Lucas artesian aquifer from leaky abandoned gas wells in southwestern Ontario	10,000
2018/19	Prateep Nayak Environment, Enterprise and Development	Water wither why: Understanding change in aquatic commons through the lens of commonisation and decommonisation	19,400
2018/19	Martin Ross Earth and Environmental Sciences	Water resources in glacial aquifers of west-central Finland: from geological to hydrogeological models to support sustainable groundwater management	18,000
2018/19	Larry Swatuk Environment, Enterprise and Development	Towards a decision support tool for progressive climate action: Comparing and assessing approaches to systems and sustainability	19,875

## Appendix C: Publications 2009 to 2017

[SGRC secretary note - Appendix C found here](#)

## Appendix D: Scholarship Recipients

#	Year	Recipient	Degree	Department	Scholarship Sponsor	Scholarship Amount (\$)
1	2011/12	MacDonald, Lauren	PhD	Biology	Golder Associates	5,000
2	2011/12	Rosamond, Madeline	PhD	Earth & Environmental Sciences	ARCADIS	5,000
3	2011/12	Tondu, Jana	Masters	Biology	Golder Associates	5,000
4	2011/12	Wilkes, Taylor	Masters	Environment, Resources & Sustainability	ARCADIS	5,000
5	2012/13	Knopf, Lillian	Masters	Biology	Golder Associates	5,000
6	2012/13	Sauder, Laura	PhD	Biology	ARCADIS	5,000
7	2012/13	Soontiens, Nancy	PhD	Applied Mathematics	Golder Associates	5,000
8	2013/14	Arlos, Maricor Jane	PhD	Biology	RBC Foundation	10,000
9	2013/14	Aziz, Tariq	PhD	Earth & Environmental Sciences	RBC Foundation	10,000
10	2013/14	Chen, Fei (Alex)	PhD	Civil & Environmental Engineering	AECOM	5,000
11	2013/14	Crichton, Alexandra	MSc	Biology	RBC Foundation	5,000
12	2013/14	Ketcheson, Scott	PhD	Geography & Environmental Management	Stantec	5,000
13	2013/14	Khedr, Ayman El Sayed	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
14	2013/14	Mead, Jennifer	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
15	2013/14	Memartoluie, Ghazal	PhD	Economics	RBC Foundation	10,000
16	2013/14	Mendoza, Jessica	Masters	Biology	AECOM	5,000
17	2013/14	Pasha, Ehsan	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
18	2013/14	Powley, Helen	PhD	Earth & Environmental Sciences	Golder Associates	5,000
19	2013/14	Raj, Arun	MES	Environment, Enterprise & Development	RBC Foundation	5,000
20	2013/14	Saunders, Grace Helena	MES	Environment, Enterprise & Development	RBC Foundation	5,000
21	2013/14	Scarlett, Sarah Joan	MSc	Geography & Environmental Management	RBC Foundation	5,000
22	2013/14	Selvaraj, Ashok	MES	Environment, Enterprise & Development	RBC Foundation	5,000
23	2013/14	Sine, Sarah Elizabeth	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
24	2013/14	Sultana, Sajida	MES	Environment, Enterprise & Development	RBC Foundation	5,000
25	2013/14	Vlad, Silvia	Masters	Civil & Environmental Engineering	Golder Associates	5,000
26	2013/14	Zhou, Ying	MES	Environment, Enterprise & Development	RBC Foundation	5,000
27	2014/15	Adams, Aurleia	MArch	Architecture	RBC Foundation	1,650
28	2014/15	Arlos, Maricor	PhD	Biology	Golder Associates	5,000
29	2014/15	Baldwin, Janis Rachel	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
30	2014/15	Balliston, Nicole	MSc	Geography & Environmental Management	RBC Foundation	5,000
31	2014/15	Brown, Catherine	MSc	Geography & Environmental Management	RBC Foundation	5,000
32	2014/15	Choundhury, Tahina	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
33	2014/15	Coutino, Aaron	MMath	Applied Mathematics	RBC Foundation	5,000
34	2014/15	Gharedaghloo, Behrad	PhD	Geography & Environmental Management	RBC Foundation	10,000
35	2014/15	Leung, Jessica	PhD	Biology	RBC Foundation	10,000
36	2014/15	Liu, Gregory	PhD	Chemical Engineering	AECOM	5,000
37	2014/15	Liu, Hongli	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
38	2014/15	Liu, Kai	Masters	Earth & Environmental Sciences	AECOM	5,000
39	2014/15	McCann, Emily	MSc	Biology	RBC Foundation	5,000
40	2014/15	McCarter, Colin	PhD	Geography & Environmental Management	Golder Associates	5,000
41	2014/15	Menkveld, Paul	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
42	2014/15	Milojevic, Tatjana	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
43	2014/15	Sabur, Md Abdus	PhD	Earth & Environmental Sciences	RBC Foundation	10,000

#	Year	Recipient	Degree	Department	Scholarship Sponsor	Scholarship Amount (\$)
44	2014/15	Saurette, Emily Marie	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
45	2014/15	Simonetti, Lorenzo	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
46	2014/15	Smith, Lauren	MES	Environment, Enterprise & Development	RBC Foundation	5,000
47	2014/15	Wang, Alana Ou	PhD	Earth & Environmental Sciences	RBC Foundation	10,000
48	2014/15	Worthington, Laura	MSc	Biology	RBC Foundation	5,000
49	2014/15	Yang, Zhe	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
50	2014/15	Zhou, Ye	Masters	Civil & Environmental Engineering	Stantec	5,000
51	2015/16	Aukes, Pieter	PhD	Earth & Environmental Sciences	Golder Associates	5,000
52	2015/16	Bedjera, Sabrina	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
53	2015/16	Bizmark, Navid	PhD	Chemical Engineering	RBC Foundation	10,000
54	2015/16	Cheng, Frederick	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
55	2015/16	Chlumsky, Robert	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
56	2015/16	Cohen-Murison, Rachel	MArch	Architecture	RBC Foundation	5,000
57	2015/16	David, Karine	PhD	Environment, Resources & Sustainability	RBC Foundation	10,000
58	2015/16	Hicks, Keegan	PhD	Biology	AECOM	5,000
59	2015/16	Lakhani, Safira	MArch	Architecture	RBC Foundation	5,000
60	2015/16	Lindamood, Danielle	MES	Environment, Enterprise & Development	RBC Foundation	5,000
61	2015/16	Markelov,Igor	PhD	Earth & Environmental Sciences	RBC Foundation	10,000
62	2015/16	Morrison, Sean	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
63	2015/16	Murray, Kimberley	Masters	Geography & Environmental Management	Stantec	5,000
64	2015/16	Raso, Thommaso	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
65	2015/16	Sim, Jun	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
66	2015/16	Sumanth, Snehanjali	MArch	Architecture	RBC Foundation	5,000
67	2015/16	Turner, Allison	MES	Environment, Resources & Sustainability	RBC Foundation	5,000
68	2015/16	Turner, Allison	Masters	Environment, Resources & Sustainability	Golder Associates	5,000
69	2015/16	Zadeh, Shabnam	PhD	Civil & Environmental Engineering	AECOM	5,000
70	2016/17	Albiladi,Abdullah	MASc	Chemical Engineering	RBC Foundation	5,000
71	2016/17	Bhatti,Suhaib	M Arch	Architecture	RBC Foundation	5,000
72	2016/17	Chandler,Laura	M Math	Applied Mathematics	RBC Foundation	5,000
73	2016/17	Coutino,Aaron	PhD	Applied Mathematics	RBC Foundation	10,000
74	2016/17	Dietrich,Amy Rose	MES	Geography & Environmental Management	RBC Foundation	5,000
75	2016/17	Elliott,James Benjamin	MES	Geography & Environmental Management	RBC Foundation	5,000
76	2016/17	Garda,Dorotyya Ildiko	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
77	2016/17	Gauthier,Jessica	MES	Geography & Environmental Management	RBC Foundation	5,000
78	2016/17	Glass,Brittney	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
79	2016/17	Grass,Sarah	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
80	2016/17	Ji,Xingtong	MA	Economics	RBC Foundation	5,000
81	2016/17	Kay,Mitchell Louis	MSc	Biology	RBC Foundation	5,000
82	2016/17	Klemt,Wynona	MSc	Biology	RBC Foundation	5,000
83	2016/17	Led,Katrine Orland	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
84	2016/17	Lee,Konhee	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
85	2016/17	Maciel,Sean	M Arch	Architecture	RBC Foundation	5,000
86	2016/17	Mills,Erin	PhD	Environment, Resources & Sustainability	RBC Foundation	10,000
87	2016/17	Muirhead,Christopher	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
88	2016/17	Shahid,Syed Ali	MASc	Chemical Engineering	RBC Foundation	5,000
89	2016/17	Shen,Lin	PhD	Civil & Environmental Engineering	RBC Foundation	3,350

#	Year	Recipient	Degree	Department	Scholarship Sponsor	Scholarship Amount (\$)
90	2016/17	Slowinski,Stephanie	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
91	2017/18	Bai,Xuanye	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
92	2017/18	Barber, Emily	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
93	2017/18	Battaglia, Maria	MA	Economics	RBC Foundation	5,000
94	2017/18	Brown,Genevieve	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
95	2017/18	Bullough, Michelle	M Arch	Architecture	RBC Foundation	5,000
96	2017/18	Byrnes, Danka	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
97	2017/18	Geuder, David Stuart	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
98	2017/18	Hrach, Dylan	MSc	Geography & Environmental Management	RBC Foundation	5,000
99	2017/18	King,Patrick William	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
100	2017/18	Liu, Ruogu	MA	Economics	RBC Foundation	5,000
101	2017/18	Marshall, Meredith	MSc	Geography & Environmental Management	RBC Foundation	5,000
102	2017/18	McMillan, Jason	M Arch	Architecture	RBC Foundation	5,000
103	2017/18	Njungu, Mwimanenwa	PhD	Public Health and Health Systems	RBC Foundation	10,000
104	2017/18	Ranjram,Mark	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
105	2017/18	Sandhu,Guneet	MES	Environment, Enterprise & Development	RBC Foundation	5,000
106	2017/18	Singh,Hameet Kaur	MES	Environment, Enterprise & Development	RBC Foundation	5,000
107	2017/18	Srikanthan, Nivetha	MSc	Biology	RBC Foundation	5,000
108	2017/18	Tran, Teresa	M Arch	Architecture	RBC Foundation	5,000
109	2017/18	Van Staden, Tamara	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
110	2017/18	Widurska,Iwona	MSc	Earth & Environmental Sciences	RBC Foundation	5,000
111	2017/18	Williamson, Jessica	MSc	Geography & Environmental Management	RBC Foundation	5,000
112	2018/19	Aponte, Alessandra	PhD	Environment, Resources & Sustainability	RBC Foundation	10,000
113	2018/19	Donnelly, Thomas	Masters	Chemical Engineering	RBC Foundation	5,000
114	2018/19	Grace, Andrew	PhD	Applied Mathematics	RBC Foundation	10,000
115	2018/19	Hayat, Samina	Masters	Biology	RBC Foundation	5,000
116	2018/19	Ianetta, Maththew	MASc	Civil & Environmental Engineering	RBC Foundation	5,000
117	2018/19	Jamal, Soundus	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
118	2018/19	Jasiak, Izabela	Masters	Biology	RBC Foundation	5,000
119	2018/19	Kao, Tung	Masters	Earth & Environmental Sciences	RBC Foundation	5,000
120	2018/19	Krogstad, Konrad	Masters	Earth & Environmental Sciences	RBC Foundation	5,000
121	2018/19	Mark, Melissa	Masters	Environment, Resources & Sustainability	RBC Foundation	5,000
122	2018/19	Mir, Khurso	Masters	Economics	RBC Foundation	5,000
123	2018/19	Odeyemi, Olutoyin	PhD	Environment, Resources & Sustainability	RBC Foundation	10,000
124	2018/19	Peters, Jacqueline	Masters	Earth & Environmental Sciences	RBC Foundation	5,000
125	2018/19	Pradhan, Sisir	PhD	Environment, Resources & Sustainability	RBC Foundation	10,000
126	2018/19	Prystupa, Emily	Msc	Geography & Environmental Management	RBC Foundation	5,000
127	2018/19	Radosavjevic, Jovana	PhD	Earth & Environmental Sciences	RBC Foundation	10,000
128	2018/19	Taheri, Mahkameh	PhD	Civil & Environmental Engineering	RBC Foundation	10,000
129	2018/19	Vanhof, Vicky	PhD	Geography & Environmental Management	RBC Foundation	10,000
130	2018/19	Webb, Elizabeth	Masters	Applied Mathematics	RBC Foundation	5,000
131	2018/19	Zhu, Ziang	PhD	Civil & Environmental Engineering	RBC Foundation	10,000

## Appendix E: WaterTalks Speakers

Date	Speaker	Affiliation	Topic
23-Mar-10	Michael Campana	Oregon State University	My recent life as a foreign-policy tool: Transboundary water resources and the "New Great Game" in the South Caucasus
29-Apr-10	Lorrie Minshall	Grand River Conservation Authority	Current Status of Source Water Protection Programs in the Grand River Watershed Area
29-Apr-10	Eric Hodgens	Region of Waterloo	Current Status of Source Water Protection Programs in the Grand River Watershed Area
29-Apr-10	Ian Smith	Ont. MOE	Current Status of Source Water Protection Programs in the Grand River Watershed Area
29-Apr-10	Georg Teutsch	UFZ	Current Status of Source Water Protection Programs in the Grand River Watershed Area
4-Nov-10	John Pomeroy	University of Saskatchewan	Advancing hydrological processes to better predict water resources in Canada
25-Nov-10	Andrew Paterson	Ont. MOE	Interpreting long-term data from Ontario lakes: Ecological surprises and emerging issues
13-Jan-11	Alex Campbell	Lifewater Canada	Water for the rural poor: A grassroots approach
26-Jan-11	Dean Jeffries	Environment Canada	Acid rain in Canada: Developing the critical load indicator to guide acidifying emission reductions and factors that delay aquatic ecosystem response
18-Feb-11	Jack Imhof	Trout Unlimited Canada	Learning to speak the same language: Evolution of the science and practice of managing stream corridors in Ontario
24-Mar-11	Steve Hrudu	University of Alberta	The Environmental and health impacts of Canada's oil sands
21-Jul-11	John Quinn	National Institute of Water & Atmospheric Research, New Zealand	Rural land use and streams in New Zealand: Overview and use of Bayesian Networks to guide interdisciplinary research and consensus decision-making
26-Sep-11	Masaki Hayashi	University of Calgary	Alpine hydrogeology: Groundwater flow and storage in moraine and talus sediments
6-Oct-11	Lewis Jonker	University of the Western Cape, South Africa	Thinking differently about water: Implications for capacity building programs
1-Nov-11	Lloyd Treinish	IBM Thomas J Watson Research Center	Coupled environmental modelling for business decision making
16-Nov-11	Garth van der Kamp	Environment Canada	Prairie groundwater and prairie wetlands: 50 years of observations and changing concepts
18-Jan-12	Roland Hall	University of Waterloo	Information across broad spatial and temporal scales is important for water resource management: A case study from the Peace-Athabasca Delta
10-Feb-12	Gerald Pollack	University of Washington	The secret life of water: E=H <sub>2</sub> O
15-Feb-12	Zafar Adeel	United Nations University INWEH	Crawling under the roadblocks to global water solutions

Date	Speaker	Affiliation	Topic
29-Mar-12	Jeffrey McDonnell	Oregon State University	Conceptualizing runoff processes in headwater catchments
28-Jun-12	Trevor Dickinson	University of Guelph	How rising temperatures have changed winter hydrology across Ontario
10-Aug-12	Everton de Oliveira	Hidroplan and State University of Sao Paulo at Rio Claro, Brazil	Water compensation: A breakthrough to make it happen
20-Sep-12	Eran Feidelson	Hebrew University of Jerusalem	Water, the real conflict in the Middle East?
27-Sep-12	Ray Ison	Open University, UK and Monash University, Australia	Australia's Murray-Darling Basin: A systemic governance approach
3-Oct-12	Maurice Dusseault	University of Waterloo	Water demands for hydraulic fracturing and shale gas development
6-Nov-12	John B. Czarnecki	U.S. Geological Survey	Assessing groundwater sustainable yield in Arkansas
17-Jan-13	Rick Everdell	Ontario Power Generation	The Niagara Tunnel Project: Planning, design and construction of a hydroelectric wonder
17-Jan-13	Paul Moorhouse	Hatch	The Niagara Tunnel Project: Planning, design and construction of a hydroelectric wonder
28-Feb-13	Michael Azulay	Ontario Ministry of Infrastructure	International Water Law
17-Sep-13	Philippe Vidon	The State University of New York	Multi-contaminant dynamics in riparian zones in the US Midwest: Driving variables, pollution trade-offs, and implications for water and air quality management?
12-Dec-13	Mike Paterson	International Institute for Sustainable Development	Towards a new vision for the Experimental Lakes Area
12-Mar-14	Mike Stone	UW Department of Geography and Environmental Management	Long term impacts of large scale land disturbance by wildfire on water quality in the Oldman River basin, Alberta
18-Jun-14	David Schindler	University of Alberta	Canada's Freshwater in the 21 <sup>st</sup> Century
3-Oct-14	Ryan Mulligan	Queen's University	Coastal responses to hurricane forcing from beaches to estuaries.
20-Oct-14	Mohamed Abdrabo	Alexandria University, Egypt	Policy-oriented climate change adaptation research center: The Nile Delta experience
20-Nov-14	Nigel Watson	Lancaster University, United Kingdom	Learning at Loweswater: An experiment in interdisciplinary water science and collaborative catchment management
26-Nov-14	Mark Redwood	International Development Research Centre, Ottawa, Canada	Water, Development and our Uncertain Future
11-Dec-14	Althea Grundling	Agricultural Research Council - Institute for Soil, Climate and Water, South Africa	South Africa Peatlands
29-Jan-15	Thomas Harter	University of California Davis, U.S.A.	Future of groundwater management in California
5-Mar-15	John Smol	Queens University	Exploring the past to protect our future: Using lake sediments to study water quality issues

Date	Speaker	Affiliation	Topic
12-Mar-15	Charles Vorosmarty	City University of New York, U.S.A.	Water in the 21st Century: Sources of pessimism, sources of optimism
17-Mar-15	Sheila Olmstead	University of Texas at Austin, U.S.A.	Water resources and climate change adaptation: An Economist's perspective
18-Mar-15	Roy Brouwer	VU University, Amsterdam, The Netherlands	Socio-economisc assessment of reducing micropollutants in wastewater
17-Jun-15	T. Pradeep	Indian Institute of Technology Madras, Chennai, India	Affordable Clean Water using Nanomaterials
29-Oct-15	Dustin Garrick	McMaster University	Pathways to Water Security for Rivers under Pressure: Water Markets and Transboundary Governance in Austalia and Western North America
12-Nov-15	Vikram Soni	Centre for Theoretical Physics, Jamia Millia Islamia, New Delhi, India	Towards Self-Sustaining, Natural Cities: Floodplain Recharge and Subterranean Mineral Water in India
19-Nov-15	Gustaaf Jacobs	San Diego State University	Lagrangian Coherent Structures and DNS with Discontinuous Galerkin methods
26-Nov-15	John Reynolds	Simon Fraser University	Salmon-fuelled ecosystems of the Great Bear Rainforest
28-Jan-16	Sharachchandra Lele	Ashoka Trust for Research in Ecology and the Environment, India	Bridging Many Divides: Building an Interdisciplinary Understanding of Water Issues in Developing Country Context
22-Feb-16	Priyanka Jamwal	Ashoka Trust for Research in Ecology and the Environment, India	Rethinking the framework for regulating water quality in urbanizing watersheds
25-Feb-16	Susan Hubbard	Lawrence Berkeley National Laboratory	Geophysical Approaches for Quantifying Watershed Structure and Function
14-Mar-16	Eric Peterson	Hakai Institute	Wired Watershed: Hakai's critical zone observatory on BCs coastal margin
24-Mar-16	Peter Mollinga	School of Oriental and African Studies, University of London	On publishing in the journal Water Alternatives
24-Mar-16	Peter Mollinga	School of Oriental and African Studies, University of London	Downstream of the dam: Farmers, pipelines and capitalist development in the Sardar Sarovar project
28-Mar-16	Bejoy Thomas	Ashoka Trust for Research in Ecology and the Environment, India	Resilience, vulnerability and environmental change: Insights from the rapidly urbanizing Arkavathy sub-basin, India
31-Mar-16	Prabhakar Clement	Auburn University	Worthiness of Complex Groundwater Models for Decision Making - When Should we say Enough is Enough?
6-Apr-16	Veena Srinivasan	Ashoka Trust for Research in Ecology and the Environment, India	The case for problem-driven water research in the developing world: Lessons from India
15-Sep-16	Pieter van der Zaag	UNESCO-IHE Institute for Water Education, and Delft University of Technology, The Netherlands	Water Storage: Nature-based Solutions for Resilient Communitites

Date	Speaker	Affiliation	Topic
27-Sep-16	Genevieve Ali	University of Manitoba	Preserving Prairie Wetland Hydrological and Biogeochemical Functions: What do we need to know?
19-Oct-16	Merrell-Ann Phare	Centre for Indigenous Environmental Resources	Water Co-Governance and Collaborative Consent: Working in partnership with Indigenous peoples to protect water and honour the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)
3-Nov-16	Mark Mattson	Lake Ontario Waterkeeper	Help Ensure a Swimmable, Drinkable, Fishable Canada
12-Jan-17	Christian Stamm	eawag, aquatic research	Unravelling the impacts of wastewater-born micropollutants in stream ecosystems
30-Jan-17	Richard Luthy	Stanford University	Urban Water Supply Re-invention for Dry Cities
31-Jan-17	John Lindsay	University of Guelph	Using open-access GIS to address issues in spatial hydrological modelling
16/2/2017	Alexander Mayer	Michigan Technological University	Developing the Great Lakes' Blue Economy: Water Productivity, Water Depletion, and Virtual Water Trade in the Great Lakes Basin
24/2/2017	Dmitri Kavetski	Univeristy of Adelaide, Australia	From uncertainty quantification to hypothesis-testing in hydrological application: Review of recent advances
16/3/2017	Diane Dupont	Brock University	Floods and droughts: Eliciting customer willingness-to-pay and adverse event likelihood priors for public utility pricing
30/3/2017	Joan Rose	Michigan State University	Monitoring pathogen concentrations in sewage to inform treatment goals and public health risks
12-Apr-17	Jeremy Schmidt	Durham University, UK	Water: Abundance, scarcity, and security in the age of humanity
30-May-17	Ni-Ban Chang	University of Central Florida, USA	Machine Learning in Support of Satellite Remote Sensing for Water Quality Monitoring in Eutrofied Lakes
Jun 19/17	Janet Hering	Eawag, Swiss Federal Institute of Aquatic Science and Technology, Switzerland	Linking Eawag's Research to Policy and Practice
Jun 28/17	Sascha Oswald	University of Potsdam, Germany	Detailed monitoring of microplastic particles in an urban water course facilitated by a novel, powerful detection method - an approach for identifying dynamic inputs of microplastics.
Aug 28/17	Ståle Navrud	Norwegian University of Life Sciences, Norway	How to value marine and coastal ecosystem services for policy use
Sep 8-17	Max Maurer	Eawag, Swiss Federal Institute of Aquatic Science and Technology, Switzerland	Data instead of concrete? Exploring the potential of digitization in urban drainage
Sep 15/17	Günter Blöschl	TU Wien, Austria	Emerging outcomes from a cross-disciplinary doctoral programme on water resource systems
Sep 18/17	Antje Witting	University of Konstanz, Germany	Policy learning in the context of urban flood mitigation

Date	Speaker	Affiliation	Topic
Oct 5/17	Arnold Heemink	Delft University of Technology, The Netherlands	Storm surge forecasting using data assimilation
Oct 24/17	Diane Orihel & Alana Greaves	Queen's University	The importance of ecosystem-based ecotoxicology for advancing environmental policy, with special reference to Canadian Oil Sands development
Oct 26/17	Kevin Boyle	Virginia Tech, USA	From the Exxon Valdez oil spill to the BP Deep Horizon oil spill: A story of economic damages from major environmental contamination events
Nov 30/17	John Hartig	Balsillie School of International Affairs, UW, WLU, CIGI	Bringing Conservation to Cities: Lessons from Building the Detroit River International Wildlife Refuge
Jan 11/18	Barbara Sherwood Lollar	University of Toronto	Exploration of the Earth's deep hydrogeosphere and subsurface microbial life
Feb 14/18	Piet Klop	PGGM, The Netherlands	Water-related risks and opportunities: An institutional investor's perspective
Feb 22/18	Emily Stanley	University of Wisconsin, Madison	Aquatic methane at small and large scales
Mar 8/ 18	Daniel McLaughlin	Virginia Tech, USA	Wetland water storage: Drivers and functions at varying spatial scales
Mar 29/ 18	Jay Austin	University of Minnesota, Duluth	Winter conditions, ice, and climate change on Lake Superior
Apr 10/18	Sharon Megdal	University of Arizona	Groundwater governance and management research: Connecting researchers and practitioners
May 24/18	Ryan Walter	California Polytechnic State University	What lies beneath: Internal waves in the nearshore coastal environment
Jun 13/18	Curtis Richardson	Duke University	Decoding the secrets of carbon preservation in peatlands along a boreal to tropical gradient from Minnesota to Peru
Jun 18/18	Ximing Cai	University of Illinois at Urbana-Champaign	Modelling river basins as coupled human and natural systems
Oct 4/18	How Yong Ng	National University of Singapore, Singapore	Research activities at the National University of Singapore Environmental Research Institute
Oct 18/18	William Blomquist	Indiana University - Purdue University Indianapolis	Notes from underground: A groundwater perspective on water resource governance and management
Nov 1/18	Gregory Baird	The Water Finance Research Foundation	Perspectives on the sustainable water infrastructure challenge: Engineering, technology or financial crisis
Nov 7/18	Margaret Palmer	University of Maryland	Restoration, watershed context and biogeochemical processes: From streams to wetlands
Nov 29/18	Keith Hipel	University of Waterloo	Negotiations over groundwater contamination

## Appendix F: Revenue and Expenses 2014-15 to 2018-19

INCOME		2014/15	2015/16	2016/17	2017/18	2018/19
		Actual	Actual	Actual	Actual	Forecast
Budget Transfer In	Operating	350,000	350,000	350,000	350,000	350,000
	Seed Grants	100,000	150,000	150,000	150,000	150,000
	Carryforward	174,280	139,581	107,382	76,214	93,366
	Other	25,000	12,000	7,949	4,009	0
	<b>Subtotal</b>	<b>649,280</b>	<b>651,581</b>	<b>615,331</b>	<b>580,223</b>	<b>593,366</b>
Budget Transfer Out	Seed Grants	96,875	146,812	74,474	148,372	150,000
	ED Research Stipend	0	0	30,000	30,000	30,000
	Other	10,749	13,500	0	13,205	10,000
	<b>Subtotal</b>	<b>107,624</b>	<b>160,312</b>	<b>104,474</b>	<b>191,577</b>	<b>190,000</b>
Other Revenue In	Grants and Contracts	33,538	34,610	2,000	103,359	45,000
	Other	0	0	0	16,975	1,000
	<b>Subtotal</b>	<b>33,538</b>	<b>34,610</b>	<b>2,000</b>	<b>120,334</b>	<b>46,000</b>
<b>TOTAL INCOME IN</b>		<b>575,194</b>	<b>525,879</b>	<b>512,857</b>	<b>508,980</b>	<b>449,366</b>
EXPENSES		2014/15	2015/16	2016/17	2017/18	2018/19
		Actual	Actual	Actual	Actual	Forecast
Salary Expenses	Salary F/T	348,403	283,622	268,203	277,878	306,000
	Salary P/T & Casual	1,309	5,513	11,781	8,272	1,000
	Other	6,752	5,000	231		5,000
	ED Stipend		11,667	35,000	35,000	35,000
	<b>Subtotal</b>	<b>356,464</b>	<b>305,802</b>	<b>315,215</b>	<b>321,150</b>	<b>347,000</b>
Office Expenses	Miscellaneous	1,553	5,450	12,169	6,748	1,500
	Postage	568	324	88	520	1,400
	Printing	7,862	5,450	1,862	9,187	7,000
	Promotion & Advertising	1,836		14,932	6,332	14,000
	Sponsorship	6,268	11,630	5,000	1,250	4,500
	Supplies	5,963	5,860	3,923	6,350	2,500
	Telephone	2,279	3,878	4,614	7,083	6,000
	Professional Development	5,000		495	0	5,000
	Computing	1,902	1,107	866	4,595	1,500
	Equipment	388	8,046	3,122	5,472	2,000
	Other		1,893	677		1,500
	<b>Subtotal</b>	<b>33,619</b>	<b>43,638</b>	<b>47,748</b>	<b>47,537</b>	<b>46,900</b>
Program Expenses	Hospitality	22,459	21,862	16,238	27,417	23,000
	Accommodation				4,176	8,000
	Airfare				6,458	14,500
	Other	28,071	47,195	57,442	8,876	6,500
	<b>Subtotal</b>	<b>50,530</b>	<b>69,057</b>	<b>73,680</b>	<b>46,927</b>	<b>52,000</b>
<b>TOTAL EXPENSES OUT (NON SALARY)</b>		<b>84,149</b>	<b>112,695</b>	<b>121,428</b>	<b>94,464</b>	<b>98,900</b>
<b>TOTAL EXPENSES OUT</b>		<b>440,613</b>	<b>418,497</b>	<b>436,643</b>	<b>415,614</b>	<b>445,900</b>
<b>TOTAL INCOME IN - TOTAL EXPENSES OUT (LESS CARRYFORW)</b>		<b>-39,699</b>	<b>-32,199</b>	<b>-31,168</b>	<b>17,152</b>	<b>-89,900</b>
<b>CARRYFORWARD</b>		<b>139,581</b>	<b>107,382</b>	<b>76,214</b>	<b>93,366</b>	<b>3,466</b>

## Appendix G: Budget Scenarios 2019-20 to 2023-24

### Scenario 1: Maintain Current Funding

INCOME		2019/20	2020/21	2021/22	2022/23	2023/24
		Budget	Budget	Budget	Budget	Budget
Budget Transfer In	Operating	350,000	350,000	350,000	350,000	350,000
	Seed Grants	150,000	150,000	150,000	150,000	150,000
	Carryforward	3,466	0	0	0	0
	Other					
	<b>Subtotal</b>	<b>503,466</b>	<b>500,000</b>	<b>500,000</b>	<b>500,000</b>	<b>500,000</b>
Budget Transfer Out	Seed Grants	150,000	150,000	150,000	150,000	150,000
	ED Research Stipend	30,000	30,000	30,000	30,000	30,000
	Other					
	<b>Subtotal</b>	<b>180,000</b>	<b>180,000</b>	<b>180,000</b>	<b>180,000</b>	<b>180,000</b>
Other Revenue In	Grants and Contracts	50,000	50,000	50,000	50,000	50,000
	Other					
	<b>Subtotal</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>
<b>TOTAL INCOME IN</b>		<b>373,466</b>	<b>370,000</b>	<b>370,000</b>	<b>370,000</b>	<b>370,000</b>
<b>EXPENSES</b>						
		<b>2019/20</b>	<b>2020/21</b>	<b>2021/22</b>	<b>2022/23</b>	<b>2023/24</b>
		<b>Budget</b>	<b>Budget</b>	<b>Budget</b>	<b>Budget</b>	<b>Budget</b>
Salary Expenses	Salary F/T	297,574	306,501	315,696	325,167	334,922
	Salary P/T & Casual	5,000	5,000	5,000	5,000	5,000
	Other					
	ED Stipend	35,000	35,000	35,000	35,000	35,000
	<b>Subtotal</b>	<b>337,574</b>	<b>346,501</b>	<b>355,696</b>	<b>365,167</b>	<b>374,922</b>
Office Expenses	Miscellaneous	2,000	2,060	2,122	2,185	2,251
	Postage	1,000	1,030	1,061	1,093	1,126
	Printing	7,500	7,725	7,957	8,195	8,441
	Promotion & Advertising	10,000	10,300	10,609	10,927	11,255
	Sponsorship	5,000	5,150	5,305	5,464	5,628
	Supplies	3,500	3,605	3,713	3,825	3,939
	Telephone	6,500	6,695	6,896	7,103	7,316
	Professional Development	5,000	5,150	5,305	5,464	5,628
	Computing	2,000	2,060	2,122	2,185	2,251
	Equipment	2,000	2,060	2,122	2,185	2,251
	Other	500	515	530	546	563
	<b>Subtotal</b>	<b>45,000</b>	<b>46,350</b>	<b>47,741</b>	<b>49,173</b>	<b>50,648</b>
Program Expenses	Hospitality	27,600	28,428	29,281	30,159	31,064
	Accommodation	10,200	10,506	10,821	11,146	11,480
	Airfare	17,000	17,510	18,035	18,576	19,134
	Other	8,500	8,755	9,018	9,288	9,567
	<b>Subtotal</b>	<b>63,300</b>	<b>65,199</b>	<b>67,155</b>	<b>69,170</b>	<b>71,245</b>
<b>TOTAL EXPENSES OUT (NON SALARY)</b>		<b>108,300</b>	<b>111,549</b>	<b>114,895</b>	<b>118,342</b>	<b>121,893</b>
<b>TOTAL EXPENSES OUT</b>		<b>445,874</b>	<b>458,050</b>	<b>470,592</b>	<b>483,509</b>	<b>496,815</b>
<b>TOTAL INCOME IN - TOTAL EXPENSES OUT (LESS CARRYFORW</b>		<b>-75,874</b>	<b>-88,050</b>	<b>-100,592</b>	<b>-113,509</b>	<b>-126,815</b>
<b>CARRYFORWARD</b>		<b>-72,408</b>	<b>-160,458</b>	<b>-261,050</b>	<b>-374,559</b>	<b>-501,374</b>

## Scenario2: Maintain Current Programming

INCOME		2019/20	2020/21	2021/22	2022/23	2023/24
		Budget	Budget	Budget	Budget	Budget
Budget Transfer In	Operating	450,000	450,000	450,000	450,000	450,000
	Seed Grants	150,000	150,000	150,000	150,000	150,000
	Carryforward	3,466	27,592	39,542	38,950	25,441
	Other					
	<b>Subtotal</b>	<b>603,466</b>	<b>627,592</b>	<b>639,542</b>	<b>638,950</b>	<b>625,441</b>
Budget Transfer Out	Seed Grants	150,000	150,000	150,000	150,000	150,000
	ED Research Stipend	30,000	30,000	30,000	30,000	30,000
	Other					
	<b>Subtotal</b>	<b>180,000</b>	<b>180,000</b>	<b>180,000</b>	<b>180,000</b>	<b>180,000</b>
Other Revenue In	Grants and Contracts	50,000	50,000	50,000	50,000	50,000
	Other					
	<b>Subtotal</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>
<b>TOTAL INCOME IN</b>		<b>473,466</b>	<b>497,592</b>	<b>509,542</b>	<b>508,950</b>	<b>495,441</b>
<b>EXPENSES</b>						
		<b>2019/20</b>	<b>2020/21</b>	<b>2021/22</b>	<b>2022/23</b>	<b>2023/24</b>
		<b>Budget</b>	<b>Budget</b>	<b>Budget</b>	<b>Budget</b>	<b>Budget</b>
Salary Expenses	Salary F/T	297,574	306,501	315,696	325,167	334,922
	Salary P/T & Casual	5,000	5,000	5,000	5,000	5,000
	Other					
	ED Stipend	35,000	35,000	35,000	35,000	35,000
	<b>Subtotal</b>	<b>337,574</b>	<b>346,501</b>	<b>355,696</b>	<b>365,167</b>	<b>374,922</b>
Office Expenses	Miscellaneous	2,000	2,060	2,122	2,185	2,251
	Postage	1,000	1,030	1,061	1,093	1,126
	Printing	7,500	7,725	7,957	8,195	8,441
	Promotion & Advertising	10,000	10,300	10,609	10,927	11,255
	Sponsorship	5,000	5,150	5,305	5,464	5,628
	Supplies	3,500	3,605	3,713	3,825	3,939
	Telephone	6,500	6,695	6,896	7,103	7,316
	Professional Development	5,000	5,150	5,305	5,464	5,628
	Computing	2,000	2,060	2,122	2,185	2,251
	Equipment	2,000	2,060	2,122	2,185	2,251
	Other	500	515	530	546	563
	<b>Subtotal</b>	<b>45,000</b>	<b>46,350</b>	<b>47,741</b>	<b>49,173</b>	<b>50,648</b>
Program Expenses	Hospitality	27,600	28,428	29,281	30,159	31,064
	Accommodation	10,200	10,506	10,821	11,146	11,480
	Airfare	17,000	17,510	18,035	18,576	19,134
	Other	8,500	8,755	9,018	9,288	9,567
	<b>Subtotal</b>	<b>63,300</b>	<b>65,199</b>	<b>67,155</b>	<b>69,170</b>	<b>71,245</b>
<b>TOTAL EXPENSES OUT (NON SALARY)</b>		<b>108,300</b>	<b>111,549</b>	<b>114,895</b>	<b>118,342</b>	<b>121,893</b>
<b>TOTAL EXPENSES OUT</b>		<b>445,874</b>	<b>458,050</b>	<b>470,592</b>	<b>483,509</b>	<b>496,815</b>
<b>TOTAL INCOME IN - TOTAL EXPENSES OUT (LESS CARRYFORWARD)</b>		<b>24,126</b>	<b>11,950</b>	<b>-592</b>	<b>-13,509</b>	<b>-26,815</b>
<b>CARRYFORWARD</b>		<b>27,592</b>	<b>39,542</b>	<b>38,950</b>	<b>25,441</b>	<b>-1,374</b>

## Appendix H: Faculty Survey Results

Q1. IN YOUR OPINION, HOW IMPORTANT ARE THE FOLLOWING WATER INSTITUTE ACTIVITIES:						
ITEM	EXTREMELY IMPORTANT	VERY IMPORTANT	MODERATELY IMPORTANT	SLIGHTLY IMPORTANT	NOT IMPORTANT	TOTAL
– Establishing a strategic WI research agenda	28.57% 8	35.71% 10	25.00% 7	10.71% 3	0.00% 0	28
– Facilitating the development of interdisciplinary research teams	57.14% 16	35.71% 10	7.14% 2	0.00% 0	0.00% 0	28
– Supporting interdisciplinary teams in pursuing research funding	57.14% 16	28.57% 8	10.71% 3	3.57% 1	0.00% 0	28
– Providing project management support to interdisciplinary research projects	10.71% 3	28.57% 8	42.86% 12	7.14% 2	10.71% 3	28
– Providing communications support to interdisciplinary research projects	21.43% 6	53.57% 15	17.86% 5	3.57% 1	3.57% 1	28
– Providing knowledge mobilization support to interdisciplinary research projects	32.14% 9	32.14% 9	28.57% 8	7.14% 2	0.00% 0	28
– Communicating and promoting WI faculty member research results and impacts	32.14% 9	42.86% 12	25.00% 7	0.00% 0	0.00% 0	28
– Administering the WI Seed Grants program	46.43% 13	32.14% 9	14.29% 4	3.57% 1	3.57% 1	28
– Supporting the Collaborative Water Graduate Program	53.57% 15	32.14% 9	14.29% 4	0.00% 0	0.00% 0	28
– Administering the WI RBC Visiting Fellows program	14.29% 4	53.57% 15	25.00% 7	7.14% 2	0.00% 0	28
– Supporting Students of the Water Institute, Graduate Section (SWIGS)	46.43% 13	32.14% 9	21.43% 6	0.00% 0	0.00% 0	28
– Establishing strategic partnerships with other universities or research institutes	32.14% 9	21.43% 6	28.57% 8	17.86% 5	0.00% 0	28

<b>Q1. IN YOUR OPINION, HOW IMPORTANT ARE THE FOLLOWING WATER INSTITUTE ACTIVITIES:</b>						
<b>ITEM</b>	<b>EXTREMELY IMPORTANT</b>	<b>VERY IMPORTANT</b>	<b>MODERATELY IMPORTANT</b>	<b>SLIGHTLY IMPORTANT</b>	<b>NOT IMPORTANT</b>	<b>TOTAL</b>
– Organizing visits by international delegations	14.29% <b>4</b>	35.71% <b>10</b>	28.57% <b>8</b>	21.43% <b>6</b>	0.00% <b>0</b>	28
– Organizing WI conferences, symposia or World Water Day events	39.29% <b>11</b>	32.14% <b>9</b>	17.86% <b>5</b>	10.71% <b>3</b>	0.00% <b>0</b>	28
– Organizing the WI RBC Distinguished Lecture	28.57% <b>8</b>	42.86% <b>12</b>	17.86% <b>5</b>	10.71% <b>3</b>	0.00% <b>0</b>	28
– Organizing the WI WaterTalks lecture series	32.14% <b>9</b>	42.86% <b>12</b>	21.43% <b>6</b>	3.57% <b>1</b>	0.00% <b>0</b>	28
– Organizing WI WaterConnections industry liaison events	10.71% <b>3</b>	64.29% <b>18</b>	17.86% <b>5</b>	3.57% <b>1</b>	3.57% <b>1</b>	28

<b>Q2: To-date, how do you and your research group benefit from membership in the Water Institute?</b>	<b>Q3: In the future, how might the Water Institute provide greater benefits to you and your research group?</b>
information on new research in other water fields,	Hold strategic workshops on identified key areas with the idea of developing cross-disciplinary projects in response to or better yet ahead of funding opportunities; proactive in creating opportunities for ground-breaking cross-disciplinary activities on campus that may not be obvious to a researcher who is "head down" and on the treadmill in their own field
I was able to connect with researchers affiliated with research institutes in partnership with the Water Institute.	It would be very helpful if the Water Institute could provide more funding opportunities for Faculty members to hire research assistants.
We very much enjoy attending WI talks and your news blasts. WI has also supported dissemination of our reports.	We can work more closely together to engage WI students in our work and to promulgate successes of others.
I have not had a chance to get involved with WI activities or applied for seed funding. I will apply next round.	Collaborative research opportunities and funding opportunities
Minimally. Have benefited from research seminars but only a small number are of interest. One student is currently participating in the Collaborative Water Program and has a WI scholarship. I am involved in a couple of GWF projects. Not clear what WI's role in forming GWF was.	Unclear. WI's main focus does not seem to overlap with my main research interests.
WI seed grant, attended talks	Continue on current path
For my research, Waterloo WI demonstrates institutional support and priority of my research, helps communicate newsworthy findings, and the Collaborative Water Program helps me attract and retain top calibre grad students	Not sure - doing a great job. Maybe to connect me with social scientists who can help navigate the politics of indigenous groups

Q2: To-date, how do you and your research group benefit from membership in the Water Institute?	Q3: In the future, how might the Water Institute provide greater benefits to you and your research group?
I am not sure that we do.	Ensure that all research groups receive equal exposure and representation.
KM and Communications via our GWF research	Does the WI have experienced project managers/administrators that can be allocated to the research activities of individual WI faculty. I.e., I would pay for .2 FTE of salary in exchange for 1 day per week of their time.
We have direct links to WI and partner with it on a large multi-institution project. The WI CWP program is becoming instrumental in securing and retaining high quality graduate students. Most of ours do enroll in the program and feedback is typically excellent. The student focused events, awards, etc. are critical services which cannot easily be duplicated by other entities on campus.	Again, anything that can be done to enrich student experience is welcomed.
I have been always getting support from WI in my proposal applications by letter of supports and connecting with new collaborators and stakeholders and government agencies. My students are also a member of SWIGS and I hear that they are enjoying being a member of SWIGS and attending their activities. In summary, we all benefit from being a member in the WI.	I think WI has been very very successful in the past 4-5 years by organizing the events and also connecting the WI members as well as supporting the faculty members in proposals and funding. We all like the supports and updates (newsletters, Water Research and other items) that we receive from WI. I think continuing these supports and highlighting our research activities are very important. THANK YOU.
<p>1. Many (most) of my graduate students have gone through the CWP, and the CWP in its current form cannot run without the support of the WI. The WI is the high tide that is floating our CWP boat.</p> <p>2. In the absence of WI, there would be vastly fewer opportunities on this campus for water people to meet each other, share ideas, hear different ideas, etc. We'd just be working away on our own, in our own little bubble.</p>	I think WI is on the right track. I'm hard pressed to think of a major thing WI could be doing to help groups like mine that it's not doing. The problem is and always will be at the "receiver" end, i.e., you can only do so much to get people to break out of their bubbles and take advantage of what is on offer.
<p>1. Some knowledge management outreach/communications</p> <p>2. Workshop funding for sessions on interdisciplinary graduate water education.</p>	Unknown at this time. My sense is that the water research I do falls well outside of the WI mandate
The WI provided seed-funding that helped us launch a coordinated research initiative in Zambia, and which has helped us leverage additional funding. Communication activities have also been important to highlight this work. We also benefit from our newly activated membership in the Collaborative Water Program.	Not sure. Doing a pretty good job at present. I would like to see a bit more effort to integrate public health more into the program, but this is as much our task as it is the WI's.
My students are regular participants in SWIGS and almost all in the CWP. I have met numerous water researchers on campus via WI events, and benefit from attending the WI talks.	I think matchmaking of researchers via targeted lunch meet-and-greets would be a low hanging fruit. Support for grant logistics is a bit tougher, but desirable.
Very helpful to be able to know what research projects are being started or are underway, and to be aware of various future possible opportunities.	Continue ongoing effort to promote interdisciplinary research, and be clear how that is different from multi-disciplinary research

Q2: To-date, how do you and your research group benefit from membership in the Water Institute?	Q3: In the future, how might the Water Institute provide greater benefits to you and your research group?
Exposure and access to information about new and on-going activities.	Not sure
Through connections for potential research partnerships, and by bringing funding opportunities to my attention	By facilitating research contacts and collaborations and opportunities to obtain research funding
From finding industry partners for grant application, and from trips to China and Bordeaux.	Seed grant, industry partner matching, international collaboration.
Connection with colleagues across campus	Communications and knowledge mobilization support
SEED Grant support to furthering ideas and collaborations - have received two SEED grants as PI and been on two grants as co-applicant Provision of an intellectual and scholarly platform to further ideas and learn On campus activities organised by the WI - workshops, lectures, debates Collaborative Water Program support graduate students through interdisciplinary course work and scholarship support	Please continue to do what you are doing which is excellent. Developing a full degree program on water
Water Institute Seed Grant Water Institute-sponsored seminars	I am interested in the Water program for my graduate students but want more integration with the Biology course requirements - otherwise it is too onerous to consider for my M.Sc. cohorts.
I have benefited through a WI seed grant.	By facilitating involvement on group research projects. I find it hard to hear about emerging research proposals in time to become a part of these. Stated another way, I often hear about WI-related projects once they are fully formed, funded and active rather than at the initial phases when it might be possible to join the project.
Promoting our research Participants in events and lectures Supported some interdisciplinary initiatives	Not certain
We have made a few connections	More connections and links to others in my field (which is peripheral to the main WI goals it seems).
Support through the Seed Grant, the CWGP, and knowledge mobilization support	Keep doing what you are doing. The WI is a great institute that continues to bring value to the University community and society more broadly.
Networking and seminars are two most important activities for us.	Great job! nothing comes to me now....
Access to international scholars; information on what UW colleagues are working on (for info and potential collaboration); exposure	I struggle to find my place in WI as someone focused on social movement activities related to water issues, but I recognize that this is probably more a function of my area of interest, the rudimentary development of my research program, and my level of engagement with the WI, than anything about WI. I am always interested in those speakers who focus on political economy and the politics of water, vs. the science, as those are the places where I meet colleagues I could see collaborating with.

**Q4: TO HELP PROMOTE YOUR RESEARCH, HOW INTERESTED WOULD YOU BE IN WORKING WITH OUR COMMUNICATIONS TEAM ON THE FOLLOWING:**

<b>ITEM</b>	<b>EXTREMELY INTERESTED</b>	<b>VERY INTERESTED</b>	<b>MODERATELY INTERESTED</b>	<b>SLIGHTLY INTERESTED</b>	<b>NOT INTERESTED</b>	<b>TOTAL</b>
– Stories for the WI website	25.00% 7	32.14% 9	39.29% 11	3.57% 1	0.00% 0	28
– Media coverage (news releases, expert advisories)	21.43% 6	32.14% 9	39.29% 11	7.14% 2	0.00% 0	28
– Videos	17.86% 5	25.00% 7	10.71% 3	28.57% 8	17.86% 5	28
– Marketing collateral (fact sheets, posters, brochures)	17.86% 5	14.29% 4	28.57% 8	17.86% 5	21.43% 6	28
– Hosting your research data (data repository)	7.14% 2	10.71% 3	28.57% 8	21.43% 6	32.14% 9	28
– Creating or refining your website (lab, project, personal bio)*	32.14% 9	25.00% 7	14.29% 4	10.71% 3	17.86% 5	28
– Guidance on how to use social media to your advantage	21.43% 6	25.00% 7	14.29% 4	14.29% 4	25.00% 7	28

## Appendix I: Letters of Support

March 1, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Faculty of Applied Health Sciences, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Two academic units within the Faculty of Applied Health Sciences – the School of Public Health and Health Systems and the Department of Recreation and Leisure Studies – are actively involved in the WI, with five faculty professors being members of the Institute. With water and health as one of our Faculty's key areas of research and teaching, the Faculty has been a significant beneficiary of WI activities and initiatives. For example, the *Queen Elizabeth Advanced Scholars* and the *Global Water Futures* program have made contributions to the research and teaching capacity of the Faculty. In addition, the WI-supported *Collaborative Water Program* is emerging as a popular program with our graduate students, and is providing them with important interdisciplinary training.

With the Faculty of Applied Health Science's growing interests and research strengths in water-related research and teaching, as well as in the environment, in global health, and in the health of Indigenous communities, I anticipate increased opportunities for collaboration and engagement with the WI. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is well-positioned as an on-campus network of water excellence, providing greater and more diverse opportunities for our faculty and students. Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain.

I strongly support the WI's renewal.

Yours sincerely,



Paul Stolee, PhD  
Professor and Interim Dean  
Faculty of Applied Health Sciences



March 4, 2019

Professor Charmaine Dean  
Vice-president University Research  
Co-chair, Senate Graduate and Research Council

Dear Professor Dean:

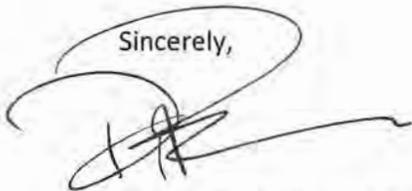
On behalf of the Faculty of Arts, I am writing to express my strongest support for the renewal of the Water Institute (WI) funding for an additional five-year period. The Institute is a glowing example of interdisciplinary Water research and Water education programs in the tradition of Waterloo's innovative approach to global challenges. Many water challenges are inherently complex, requiring a multi-faceted approach and the WI is uniquely positioned as an on-campus network of water excellence. The initiatives undertaken since the Institute's creation have placed the University at the forefront of Water research both in Canada and internationally.

The WI is truly committed to interdisciplinarity. Within our Faculty, nine professors from a variety of disciplines - Economics, Political Science, Social Development Studies and the School of Accounting - are actively involved as members of the WI, including the Institute's director, professor Bouwer. The Faculty of Arts has been a significant beneficiary of WI activities and initiatives, such as the Queen Elizabeth Advanced Scholars Program and the Global Futures Project. The research undertaken within the Institute increases the visibility of Faculty member's research to address the management of Water resources, as well as raising the profile of the University in advanced research and learning.

The WI-supported Collaborative Water Master and PhD Programs have emerged as a popular choice for Waterloo undergraduate students and students from other universities. WI graduate programs provide these students with a collaborative vision and constitute an essential resource in training interdisciplinary Water leaders that will tackle the Global challenges of tomorrow. The Seed Grants program has also funded several graduate students in the Faculty of Arts involved in Water Research.

Interdisciplinary research continues to be a goal for the Faculty of Arts and the WI provides a great space for our Faculty to engage in collaborative research and teaching. However, the Water Institute has yet to reach its full potential. The continued support for the WI will provide greater and more diverse opportunities for our faculty and students. The Faculty of Arts fully supports the renewal of funding for the Institute.

Sincerely,



Dr Douglas M Peers, FRHS  
Dean of the Faculty of Arts  
Professor of History



15 April 2019

Dr. Charmaine Dean  
Vice-President, Research and international  
University of Waterloo

Dear Charmaine,

**Subject: Renewal of the Water Institute**

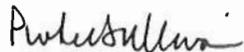
On Tuesday March 6th, the Chairs and Associate Deans (CAD) Committee of the Faculty of Engineering met to discuss a proposed 5-year renewal of the Water Institute. Such a decision must be made judiciously since it supports a request for funding commitment of minimum \$1.75M while the university is enduring government-mandated cutbacks. With this in mind, there was unanimous support by the leadership of the Faculty of Engineering for a renewal of the Water Institute for a 5-year period assuming no increase in funding.

The Water Institute is an active research center that utilizes university funding for various impactful events including a lecture series, a World Water Day event, and a number of international scientific conferences. There was strong consensus that the Water Institute effectively brings faculty and student members together from across campus to participate in, or would not exist otherwise. The institute has successfully promoted the University of Waterloo's strength and breadth in water research, producing various print and online communications. Seed grants, provided with additional funding from the Provost, have noteworthy impact by initiating new research directions. Carefully addressed previous and future strategic plan goals and activities clearly enhance the expected and future impact of the Water Institute. The faculty survey and comments provide data and feedback for future planning to guide the institute. An innovative "shared services" business model demonstrates that the Water Institute is providing tangible services as funded mostly through faculty member research projects as well as the Institute's own funding. *As such, the use of funds, role, activities, and various impacts of the Water Institute are clear.*

The Engineering Research Office would be pleased to assist the Water Institute in shaping and preparing proposals for large-scale funding opportunities that would benefit not only Engineering faculty members, but researchers from outside of Engineering to encourage and further foster interdisciplinary research.

We wish to note one concern that was raised by the Faculty leadership. This is related to the 2000 publications listed, which are not representative of the Water Institute activities, and actually detracts from the initiatives, credibility and impact of the institute. We suggest that the renewal document focus on the accomplishments of the institute and not the successes of the members resulting from their efforts. A more focused approach would also reduce the administrative burden when creating the renewal document. Our recommendation is to remove these citations for the submission to Senate Graduate & Research Council and then Engineering would be pleased to provide an updated letter of support before review by SGRC.

Yours truly,

  
Pearl Sullivan  
Dean, Faculty of Engineering



February 28, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Faculty of Environment, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

One Department and three Schools within the Faculty of Environment – Geography and Environmental Management, Environment, Enterprise and Development, Environment, Resources and Sustainability, and Planning – are actively involved in the WI, with 36 faculty professors being members of the Institute. With water as one of the Faculty of Environment’s major areas of research and teaching, the Faculty has been a significant beneficiary of WI activities and initiatives. For example, the Southern Ontario Water Consortium, the Global Water Futures, and the Queen Elizabeth Scholars programs have made major contributions to the research and teaching capacity of the Faculty, and have enhanced the profile of the Faculty and the University. In addition, the WI-supported Collaborative Water Program has emerged as a very popular program with our graduate students, and has provided them with important interdisciplinary training.

As the Faculty of Environment continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more organizations and businesses requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University’s and the WI’s history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for the Faculty of Environment, and I therefore support the WI’s renewal wholeheartedly.

Sincerely,



Jean Andrey  
Dean, Faculty of Environment



March 6, 2019

Senate Graduate Research Council  
University of Waterloo

**RE: Renewal of the Water Institute**

The Faculty of Math is pleased to support the renewal of the Water Institute (WI) at the University of Waterloo. Over the past 5 years, WI involved several members of the faculty of mathematics, in its efforts to develop cross faculty research collaborations and partnerships. Specifically, ten colleagues from the Faculty of Math are listed as members of the WI including faculty in Applied Math, Computer Science, Statistics and Actuarial Science. For example, Professor Kevin Lamb from the Department of Applied Math is conducting high-resolution numerical simulations to find patterns behind the often highly nonlinear behaviour of the Ocean's internal waves – waves that mix and brew beneath the surface. A better understanding of these waves will shed light on the role they play in large-scale ocean circulation and biological productivity. The mathematical models developed by Prof. Lamb will further our understanding of how the oceans work and the impacts of climate change on the ocean. Prof. Lamb is actively involved in the WI serving on its Strategic Management Committee among others.

The Faculty of Math believes that the WI will continue to play a significant role for the University as it strives to facilitate cross-faculty research collaborations and external collaborations for example through the Global Water Futures. We look forward to strengthening our relationships with the WI and its members over their next five-year period.

Sincerely,



Stephen M. Watt  
Dean, Faculty of Mathematics



February 19, 2019

Senate Graduate and Research Council  
University of Waterloo

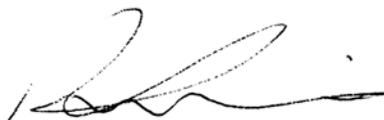
Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period. As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Faculty of Science, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Three Departments within the Faculty of Science – Earth and Environmental Sciences, Biology and Chemistry – are actively involved in the WI, with 50 professors being members of the Institute. With water as one of the Faculty of Science's major areas of research and teaching, the Faculty has been a significant beneficiary of WI activities and initiatives. For example, the CERC in Ecohydrology, the Southern Ontario Water Consortium, and the Global Water Futures program have made major contributions to the research and teaching capacity of the Faculty, and have enhanced the profile of the Faculty and the University. In addition, the WI-supported Collaborative Water Program has emerged as a very popular program with our graduate students, and has provided them with important interdisciplinary training.

As the Faculty of Science continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students. Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for the Faculty of Science, and I therefore strongly support the renewal of the Water Institute.

Sincerely,



Robert P. Lemieux, PhD  
Dean of Science and Professor of Chemistry



March 4, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Department of Applied Mathematics, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Within our department four professors (Drs. Lamb, Poulin, Stastna and Waite) are actively involved as members of the WI. With fluid dynamics as one of the department's major areas of research and teaching, we have been a beneficiary of WI activities and initiatives. For example, the faculty in our department are involved in 2 Global Water Futures projects and graduate students of all four professors have participated in the Water Institute's Collaborative Water Program. The Water Institute has also fostered connections between faculty in the department and other researchers across campus.

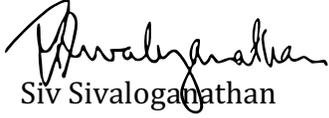
In addition, Faculty from the Department of Applied Mathematics have served on the Water Institute's Strategic Management Committee, the Collaborative Water Program Committee and are lecturing in the Water Institute's summer school in June, 2019.

As the university continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus



network of water excellence, thus providing greater and more diverse opportunities for our faculty and students. Therefor I support the WI's renewal.

Yours Sincerely,



Siv Sivaloganathan

=====

Professor & Chair,  
Dept of Applied Math,  
University of Waterloo,  
Waterloo, ON N2L 3G1



March 3, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Department of Biology, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Within Biology, we have quite a few professors (e.g., Servos, Hall, Rooney, and Swanson) whose research and teaching complement the WI and as such, we have been a significant beneficiary of WI activities and initiatives. For example:

The Southern Ontario Water Consortium;  
The Global Water Futures program;  
Queen Elizabeth Scholars program;  
Seed Grants program.

In addition, the WI-supported Collaborative Water Program has emerged as a very popular program with our graduate students, and has provided them with important interdisciplinary training.

As the Department of Biology continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for the Department of Biology, and I therefore support the WI's renewal.

Yours Sincerely,



Hugh Broders  
Chair, Department of Biology



March 5, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Department of Chemistry, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

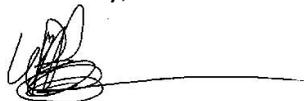
Within our Department, seven professors are actively involved as members of the WI. With water as one of Chemistry's many areas of research and teaching, we have been a significant beneficiary of WI activities and initiatives. My colleagues' involvement in the Water Institute has made major contributions to our research and teaching capacity and have enhanced the profile of the Chemistry and the University. In addition, the WI-supported Collaborative Water Program is emerging as a popular program with our graduate students and has provided them with important interdisciplinary training.

As the Department of Chemistry continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for the Department of Chemistry, and I therefore support the WI's renewal.



Sincerely,



William P. Power, Chair  
Department of Chemistry  
Phone: +1-519 888 4567, x33626  
Mobile: +1-519 241 3216  
wppower@uwaterloo.ca



February 19, 2019

Senate Graduate and Research Council  
University of Waterloo

Re: Letter of Support; Five-year review for the Water Institute

Dear Council Members:

As Chair of the Department of Economics, I am pleased to write this letter of support for the Water Institute (WI). While numerous universities around the world host water research institutes, the WI at the University of Waterloo is unique in its commitment to interdisciplinarity. While the majority of WI members are associated with Science, Engineering, and Environment, the WI makes a concerted effort to involve researchers from the humanities, social sciences and health. Promoting true interdisciplinary research is an on-going challenge, but I see the WI having had considerable success and I expect increased success in the future.

In Economics, in addition to Executive Director Roy Brouwer, we have three faculty members whose main research interests lie in Environmental and Natural Resource Economics. These researchers, Dr. Horatiu Rus, Dr. Alain Nimubona, and myself, have the most natural connection to the Water Institute. Dr. Alain Nimubona has benefited from the WI through two Seed grants for projects with collaborators from Environment. Several of our graduate students have benefited from funding from the WI, including my PhD student, Xinyuan Yang, who has received funding through the Global Water Futures Project.

The Collaborative Water Program is one of the WI's great successes. Students who have gone through the CWP will find it easier to undertake interdisciplinary research due to the knowledge and connections received in that program. A number of students from Economics have benefited from the CWP.

In summary, the WI is a unique research center which, in my opinion, has yet to reach its full potential. The University should continue to nurture it by renewing its funding.

Sincerely,



Margaret Insley

Associate Professor and Department Chair



March 5, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am very pleased to be writing to you at this time to provide a perspective on the value and unique significance of the Water Institute (WI) at the University of Waterloo and to indicate my clear support for the renewal of institute status for WI for an additional five-year cycle. The Department of Earth and Environmental Sciences (EES) was involved in the initial establishment of WI and its development during the early and intermediate stages of its operation. As EES has a substantial program related to water science, many of our faculty members and students are directly involved with the programs and activities within WI and have been members for many years.

WI has made it a priority to encourage and facilitate interdisciplinary water research both on campus and within our national and international networks of our collaborating scientists and institutions. This has provided members of EES with an unprecedented opportunity to engage in collaborative projects with other water researchers and partners in a way that would never likely to have occurred without the influence of WI. As the scope of water science within EES is by nature highly inter and multidisciplinary, the leadership provided by WI in this regard has been invaluable, especially for our early career faculty, post doctoral fellows and graduate students. Currently, 15 (70%) of our faculty are active members of WI and over 50 graduate students within EES participate within the student chapter of WI known as SWIGS.

The existence of WI and the global recognition of its goals and functions related to modern water science has led to several very significant opportunities for EES. For example, WI was a significant factor in permitting EES to attract one of the federal government Canadian Excellence Research Chairs (CERC) to the University of Waterloo (UW), Dr. Philippe van Cappellen. As a result of the CERC, an internationally-recognized research program in the emerging area of Ecohydrology has been established within EES, involving over 50 researchers and students drawn from around the world. WI was also instrumental in helping to coordinate the Southern Ontario Water Consortium, a multi-institutional, research-based program designed to facilitate collaboration between university researchers and industrial partners in the advancement of water science, engineering and management across Canada. SOWC has provided numerous opportunities for faculty and students to become engaged in collaborative

partnerships that would not have been possible without this initiative. The program was developed and centred at UW in part because of the presence and capacity of WI. Most recently, WI has played a significant role in coordinating UW's participation within the CFREF project, Global Water Futures (GWF). GWF involves leading water research institutions across Canada and as a result of the clear recognition of UW's excellence in a diverse range of topics related to water research, as promoted and supported by WI, UW become one of the largest partners within GWF and currently well over 60 researchers and students at UW are actively involved in this world-leading research program.

In addition to the major programs mentioned above, another unique and highly valuable activity within WI has been the Seed Grants program that is designed to facilitate interdisciplinary interaction between researchers at UW and around the world. Many of our faculty and students have participated and benefited from the Seed Grants program and in several cases, this has resulted in the establishment of new research proposals and projects within our department. One of the other programs that our faculty and students have both contributed to and highly benefited from is the WI-supported Collaborative Water Program. This program exemplifies the underlying goals of WI by exposing young researchers to a broad range of issues and disciplines that are being pursued across the UW campus in the area of water research. This program has become known worldwide and is a main reason why some of our strongest new graduate students elected to enrol within water training programs at UW.

Over the last decade, as UW has placed a significant emphasis on water-related research, WI has become a major factor in supporting growth in training, research activity and collaborative activity nationally and internationally. As the management and understanding of water resources continues to grow as a global research priority, the presence and bonding influence of the Water Institute will be even more important in ensuring UW remains ranked among the top academic institutions in the world in the water domain.

Sincerely,



David L. Rudolph, Ph.D., P.Eng.  
Professor and Chair  
Department of Earth and Environmental Sciences  
519-888-4567 ext. 36778  
email: [drudolph@uwaterloo.ca](mailto:drudolph@uwaterloo.ca)

March 5, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the School of Environment, Enterprise and Development (SEED), I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Within SEED, one-third of our professors are actively involved as members of the WI. With water as one of the School's major areas of research and teaching, we have been a significant beneficiary of WI activities and initiatives. For example, the Seed Grants program has supported several projects within SEED, facilitating international research collaborations and the acquisition of significant research funding. Research project support has enhanced the national and international profile of SEED, the Faculty of Environment and the University. In addition, the WI-supported Collaborative Water Program has emerged as a very popular program with our graduate students and has provided them with important interdisciplinary training. The RBC scholarship program has supported quite a number of our students thereby enhancing the research capacity of the next generation of sustainability scholars.

As the School continues to grow its capacity in sustainable water and related resources research, teaching and training, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Given water's cross-cutting importance to the Sustainable Development Goals (SDGs) as well as SDGs 6 (sustainable water and sanitation), 14 and 15 (life on land; oceans and coastal sustainability), the Water Institute's collaborative and transdisciplinary approach to research and teaching remains an important resource for SEED and I therefore support the WI's renewal.

Yours Sincerely,



Prof. Bruce Frayne  
Director

February 18, 2019

**Re: Letter in support of the continuation of the Water Institute for an additional five years (June 2019 to May 2024).**

Dear Senate Graduate Research Council:

It is my pleasure to provide this letter indicating my support for the continuation of the Water Institute at the University of Waterloo for an additional five years.

The Water Institute supports a number of very important initiatives for the students and faculty of the School of Environment, Resources and Sustainability. A number of us have benefitted from the Water Institute's Seed Grant program to develop new research collaborations that reach across faculties and units. Our students and faculty members are regular attendees to the Water Institute's many excellent seminars by international water experts. Last year the Water Institute co-hosted, with the Canadian Rivers Institute, the 2018 Hynes Lecture. Many of our students participate actively in the Students of the Water Institute Graduate Section (SWIGS).

The Water Institute has also played a key role in the development of the Collaborative Water Program at UW. I have personally taught in both graduate courses of the CWP at different times and regard it as the best example at UW of the multi-, inter- and transdisciplinary approach to research and teaching that we are trying to develop within the School of Environment, Resources and Sustainability. CWP has grown to 67 Masters and Doctoral students from all six of our faculties and there is every reason to think that this growth will continue. I am proud that a member of our School presently serves as the Coordinator for CWP.

Please do not hesitate to contact me at the coordinates below if further information would be helpful.



Simon Courtenay, PhD  
Director, School of Environment, Resources and Sustainability  
Faculty of the Environment  
Tel.: 35796; Email: [simon.courtenay@uwaterloo.ca](mailto:simon.courtenay@uwaterloo.ca)



5 March, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario, N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period. As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Department of Geography and Environmental Management (GEM), I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Remarkably, GEM has 19 professors who are actively involved in the WI. With water as one of the Department's major areas of research and teaching, we have been a significant beneficiary of WI activities and initiatives. For example, the Southern Ontario Water Consortium, the Global Water Futures, and the Queen Elizabeth Scholars programs have made major contributions to the research and teaching capacity of the Department, and have enhanced the profile of the Department and the University. In addition, the WI-supported Collaborative Water Program has emerged as a very popular program with our graduate students, and has provided them with important interdisciplinary training. In addition, our students have greatly benefitted from the Institute's graduate student scholarship program and various knowledge transfer activities.

As the GEM continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. Many grand challenges facing the planet are water-related and are inherently complex, with solutions discoverable only through interdisciplinary research. In response, the funding landscape has shifted in scope, becoming increasingly demanding of interdisciplinary approaches for which the University is well positioned. The WI is an important catalyst for on-campus collaboration in water research excellence providing greater and more diverse opportunities for our faculty and students across traditional disciplinary boundaries.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for the Department, and I therefore very strongly support the WI's renewal.

Yours Sincerely,



Richard Kelly  
Professor and Chair, Department of Geography and Environmental Management



Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

March 3, 2019

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the School of Planning, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Within our School, a number of our professors are actively involved as members of the WI and it is a long standing central theme for of their research and teaching in Planning. The 21<sup>st</sup> Century is the "Century of the City" and the need for leadership in planning and policy around water is greater than ever. We have been a significant beneficiary of WI activities and initiatives. For example, the Southern Ontario Water Consortium, the Global Water Futures program, the Queen Elizabeth Scholars program and the Seed Grants program.

As the School of Planning continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for the School of Planning and I therefore support the WI's renewal.

Sincerely,



Clarence Woudsma, Ph.D. MCIP, RPP  
Director, School of Planning  
cwoudsma@uwaterloo.ca



March 4, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the School of Public Health and Health Systems, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Several of our faculty are actively involved as members of the WI. Aside from my own work in Africa on flood-related impacts on health systems, Drs. Brian Laird and Kelly Skinner conduct research on water contamination and water security with aboriginal communities and Dr. Shannon Majowicz focuses her work on water- and foodborne infections. One of our newest faculty, Warren Dodd, works on water management and security issues in the Philippines. In addition to external, tri-agency funding, these activities have been supported in part by the Global Water Futures program and the Queen Elizabeth Scholars Program. We have also benefitted from seed-funding provided by the WI. With water as one of our major areas of research and teaching, we have been a significant beneficiary of WI activities and initiatives.

In addition, the WI-supported Collaborative Water Program has emerged as a very popular program with our graduate students, and has provided them with important interdisciplinary training.

As the School continues to grow and profile its capacity in water-related research and teaching, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the

water domain. Water remains an important priority for the School, and I therefore support the WI's renewal.

Yours Sincerely,

A handwritten signature in black ink, appearing to read 'Craig R. Janes', written in a cursive style.

Craig R. Janes, Phd  
Professor and Director





March 4, 2019

Senate Graduate and Research Council  
University of Waterloo  
Waterloo, Ontario  
N2L 3G1

Dear Council Members:

I am writing to express my strong support for the renewal of the Water Institute (WI) for an additional five-year period.

As you know, the goal of the WI is to advance water-related research and teaching at the University of Waterloo, with a particular focus on interdisciplinary activities. On behalf of the Department of Political Science, I fully support these goals and recognize the significant progress that the WI has made towards their achievement.

Within our Department, a couple of professors are actively involved as members of the WI. In particular, Dr. Dan Henstra has been a beneficiary of WI activities and initiatives. For example, the WI has provided Dr. Henstra with networking opportunities, promotion of his research on climate change adaptation and flooding, and with help finding other researchers in Canada and abroad who are investigating similar research areas.

As scholars in the Department of Political Science continue to engage in water-related research, the collaborative and interdisciplinary model of the WI remains vital. As many water challenges are inherently complex and interdisciplinary in nature, and with more and more funders requiring interdisciplinary approaches, the WI is uniquely positioned as an on-campus network of water excellence, thus providing greater and more diverse opportunities for our faculty and students.

Based on the University's and the WI's history and achievements in water research and education, Waterloo is ranked among the top academic institutions in the world in the water domain. Water remains an important priority for our researchers and the university, and I therefore support the WI's renewal.

Yours Sincerely,

A handwritten signature in black ink, appearing to read 'A. Esselment'.

Anna Esselment, PhD  
Associate Professor and Interim Chair  
Department of Political Science  
University of Waterloo

February 28<sup>th</sup>, 2019

Dear Senate Graduate and Research Council,

I am writing this letter in support of the continuation of the Water Institute. I am familiar with the work of the Water Institute through the affiliation of one of the faculty members in my department, Dr. Robert Case. Dr. Case studies water management and governance, with a focus on community organizing around local water issues. His work serves as an excellent complement to the research on water quality and management through affiliated faculty in biology, chemistry, engineering, environment, public health, and more. The interdisciplinary collaborations, innovative strategies, and commitment to outreach and education demonstrated by the Water Institute should serve as an example for other institutes and centres in the university space. Moreover, water as a topic of study is crucial in the context of pressing societal issues such as environmental conservation, community health and well-being, and Indigenous land and water rights. I look forward to seeing what important work comes out of the Water Institute in the next five years.

Sincerely,



Denise Marigold, PhD  
Chair, Social Development Studies  
Renison University College  
University of Waterloo

## MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter  
Secretariat

Jatin Nathwani  
Executive Director, Waterloo Institute for Sustainable Energy

Bernard Duncker  
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean  
Vice-President, Research and International 

DATE: Friday April 26, 2019

RE: Support for the Waterloo Institute for Sustainable Energy, University Centre

I am pleased to inform you that, following the presentation from Jatin Nathwani, Executive Director of the University level Waterloo Institute for Sustainable Energy (WISE), at the Research Leaders Council meeting of April 17, 2019, the Council unanimously recommends support of the WISE renewal for another five-year term to Senate Graduate and Research Council.





## MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter  
Secretariat

Jatin Nathwani  
Executive Director, Waterloo Institute for Sustainable Energy

Bernard Duncker  
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean  
Vice-President, Research and International

DATE: Tuesday April 30, 2019

RE: One-Month Extension

I have issued the university level Waterloo Institute for Sustainable Energy a 1-month extension to June 30, 2019 to accommodate the renewal process as it goes before Senate in June.



April 15 2019

Dr. Charmaine Dean  
Vice-President, Research and international  
University of Waterloo

Dear Charmaine,

**Subject: Renewal of Waterloo Institute for Sustainable Energy (WISE)**

On Tuesday March 6th, the Chairs and Associate Deans (CAD) Committee of the Faculty of Engineering discussed a proposed 5-year renewal of the Waterloo Institute for Sustainable Energy (WISE). Such a decision must be made judiciously since it supports a request for a funding commitment of a minimum of \$1.75M while the university is enduring government-mandated cutbacks. With this in mind, there was unanimous support by the leadership of the Faculty of Engineering for a renewal of WISE for a 5-year period assuming no increase in funding.

WISE has been an active and engaging centre that is the entry point for energy research at UW. There is wide support for WISE and the activities of this institute support and enhance UW research initiatives in the energy field. Notably, WISE launched the Affordable Energy for Humanity (AE4H), as part of the United Nations Sustainable Goal 7, taking the initiative for international development towards “affordable, reliable, sustainable, and modern” energy. WISE has directly supported students via Energy Council of Canada fellowships and Queen Elizabeth II Diamond Jubilee Scholarship Program. WISE activities include hosting numerous conferences and workshops including WISE Energy Day, Technology and Innovation and Policy Forum, and the Resource Recovery Partnership Workshops as well as an extensive public lecture series. Dr. Nathwani, in his leadership role as Director of WISE, has engaged widely as a media spokesperson in many different fora helping to promote the University of Waterloo.

The Engineering Research Office would be pleased to assist WISE in shaping and preparing proposals for large-scale funding opportunities that would benefit not only Engineering faculty members, but researchers from outside of Engineering to encourage and further foster interdisciplinary research.

We wish to address a concern by the Faculty leadership. This is related to the reporting of journals and graduate theses as “scholarly output” from WISE that are not representative of WISE activities. Such reporting detracts from the true initiatives, credibility, and impact of the institute. We suggest that the renewal document only focus on the accomplishments of the institute and not the successes of the members resulting from their efforts. A more focused approach would also reduce the administrative burden when creating the renewal document. Our recommendation is to remove these citations for the submission to Senate Graduate & Research Council and then Engineering would be pleased to provide an updated letter of support before review by SGRC.

Yours truly,



Pearl Sullivan  
Dean, Faculty of Engineering



# Waterloo Institute for Sustainable Energy

**Five Year Review Report  
(Abridged Version)**

**2013-2018**

Prepared for the University of Waterloo  
Senate Graduate & Research Council



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# **1. MESSAGE FROM THE EXECUTIVE DIRECTOR**

## MESSAGE FROM THE EXECUTIVE DIRECTOR

Dear Senate Graduate & Research Council,

I am pleased to submit this report for the period (2013-2018) and requesting your approval for a five year renewal of the mandate of Waterloo Institute for Sustainable Energy (WISE). The report summarizes our achievements over the past five years of research excellence, energy policy leadership and development of the scientific and technical capacity to support national and global initiatives.

As we celebrate ten years of our operation as an Institute, we recognize the achievements of our members who have made significant contributions to the advancement of energy research in Canada and globally.

Although we are a small group in the global context, the impacts of our work are noticeable because we work effectively by joining hands across disciplines and build bridges over institutional barriers. Our success stories are a testament to the collective strengths of our faculty and our efforts to engage with funding agencies and external partners to grow the scope and scale of energy research at the University of Waterloo.

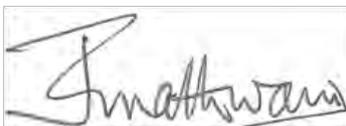
As an Institute, we have been successful in supporting our faculty members across all faculties and continue to foster a strong culture of collaboration across departments to engage in interdisciplinary research projects. The alignment of specific interests of faculty members with the needs of the broader energy sector has created a vast network of positive relationships and engagement both within the university and with external agencies. The Institute has established a solid reputation within the energy community nationally and internationally.

Our existing fossil-fuel based energy system delivers light but also casts dark shadows over the health of our environment. Greenhouse gas emissions threaten the integrity of the climate and the biophysical ecosystem. We are driven by a compelling desire to develop energy solutions that will help achieve the transition of the global energy economy to one with a lower carbon footprint.

Ensuring access to affordable energy is a key criterion for economic and social well-being. Delivering clean energy to every global citizen without compromising the long-term sustainability of the environment is an equally compelling challenge. The twin goals form the nexus of our work. Collectively, we are animated and committed to developing the right solutions for meeting this challenge: a clean environment with affordable energy access for all.

In the following pages, you will read a summary of the accomplishments of our researchers and students through their publications and presentations. We are proud of the efforts of our faculty and their unflinching commitment to work collaboratively.

I invite you to read more about the next chapter in our journey, outlined in the 'Future Directions' section.



**Jatin Nathwani, PhD, P.Eng**

Professor and Ontario Research Chair in Public Policy for Sustainable Energy  
Executive Director, Waterloo Institute for Sustainable Energy (WISE)  
Faculty of Engineering and Faculty of Environment  
Fellow, Balsillie School of International Affairs (BSIA)  
University of Waterloo, Waterloo, ON

For the **full (unabridged) report**, please click on the link below:

Link: [https://wise.uwaterloo.ca/download/documents/wise-admin/strategic-plans/senate/new\\_folder/wise\\_5\\_year\\_report\\_final\\_feb25docx-1?attachment=0](https://wise.uwaterloo.ca/download/documents/wise-admin/strategic-plans/senate/new_folder/wise_5_year_report_final_feb25docx-1?attachment=0)

## **2. THE WATERLOO INSTITUTE FOR SUSAINABLE ENERGY**

## 2.1 Mission, Vision and Strategic Objectives

WISE was founded in April 2008, building on the University's longstanding strengths in engineering, science and environmental research.

WISE advances the broader priorities of the University of Waterloo, including research excellence, interdisciplinarity, internationalization, experiential learning, and entrepreneurship. Our commitment in this regard includes the submission of a special contribution to the current UW Strategic planning process 'Bridge to 2020' (see appendix IX).

The institute provides a focal point for energy research at Waterloo and we work to create the best possible research platforms for faculty to test their ideas, engage with their peers, and partner with external organizations to accelerate the pace of research, development and deployment of practical solutions. In the ten years since our founding, WISE has become the face of sustainable energy research at Waterloo, and has established itself as a globally networked and recognized centre for research within the sustainable energy sector.

Our **vision** is simple: clean energy, accessible and affordable for all.

Our **mission** is to conduct original research and develop innovative solutions and policies to help transform the energy system for long-term sustainability.

WISE activities continue to be guided by three **strategic objectives**:

- 1. Collaborate:** To expand opportunities for interdisciplinary sustainable energy research at Waterloo and improve research productivity. This is achieved through supporting a diverse group of energy researchers from across the faculties (WISE members) in scoping new projects, developing the funding and human resources to ensure their success, and assisting with communication about research outcomes. In addition to this, WISE plays a central role in supporting students to become future sustainable energy sector leaders through a variety of research, fellowship, and experiential education programs.
- 2. Reach Out:** To promote engagement of external organizations, we work closely with government agencies, civil society organizations, and private sector companies to develop sustainable energy research at UW. This is achieved through partnership building activities that deliver significant new sources of research funding, establish long-term relationships with peer institutions, and provide platforms for our researchers to share their findings.
- 3. Influence:** To establish WISE as an authoritative source of energy insights and analysis, translate important scientific discoveries for a wide audience, and inform energy policy choices. This is achieved through annual events, publications, media exposure, and engagement with high-level decision-makers and thought leaders.

## 2.2 WISE Administration

### Staff

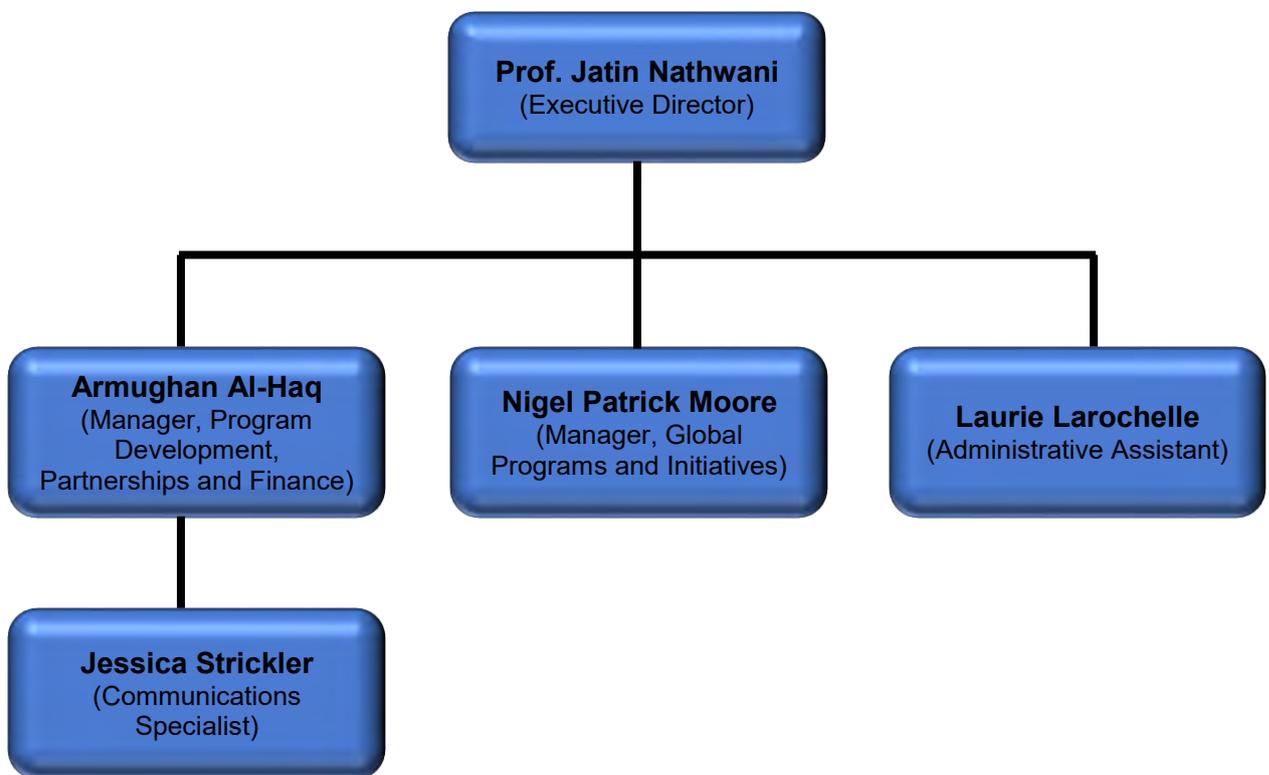
Jatin Nathwani  
Executive Director

Laurie Larochelle  
Administrative Assistant

Armughan Al-Haq  
Manager, Programs and Partnerships

Jessica Strickler  
Communications Specialist

Nigel Moore  
Manager, Global Programs and Initiatives



**Figure: Organizational Chart**

## Advisory Council

David McFadden  
Chair, International Practice & Partner, Gowling  
Lafleur Henderson LLP

Andrew Teichman  
Former Executive Director of Investments, OPG  
Ventures Inc.

Paul Murphy  
Chair of the Advisory Board, Advanced Energy  
Centre, MaRS Discovery District

George Greene  
Chair, Stratos Inc

Bruce Campbell  
Former President & CEO, IESO

William Smith  
Senior Vice President Operations &  
Engineering, Terrestrial Energy

Céline Bak  
President, Analytica Advisors

Steve Dorey  
Former Chair, Energy Council of Canada Studies  
Committee

John Wilkinson  
Senior Vice President Sustainability, Greenfield  
Global

Serge Imbrogno  
Deputy Minister of Energy, Ontario Government

Velma McColl  
Principal, Earncliffe Strategy Group

Carmine Marcello  
Executive Director, Hetherington Kearney Group

Colin Andersen  
Principal, CACS and Chair, Energy Council of  
Canada

## Senior Executive Fellows

Yves Lostanlen  
CEO, SIRADEL North America (ENGIE)

Don McCutchan  
Partner & International Policy Advisor, Gowling  
WLG LLP

Chris Henderson  
President, Lumos Energy

Catherine Jackson  
Founder, Jackson Principled Governance

Neil B. Freeman  
Principal & CEO, NBF Group Inc.

Sankaran Ramalingam  
National President, Energy & Fuel Users'  
Association of India

Thomas Gottschalk  
CEO, Mobisol Group

Zohrab Mawani  
Co-Founder & President, oneGRID Corporation

## Internal Board of Management

The Internal Board of Management provides operational oversight and approval.

The IBM Directors include:

- **WISE Executive Director**
- **Deans of Engineering, Environment and Science**
- **Eight regular WISE faculty members from the five UW faculties**

Charmaine Dean (Chair)  
Vice President, University Research

Jean Andrey  
Dean of Environment

## Section II: The Waterloo Institute for Sustainable Energy

Peal Sullivan  
Dean of Engineering

Bob Lemieux  
Dean of Science

Keith Hipel  
Professor, Faculty of Engineering  
Department of Systems Design Engineering

Heather Douglas  
Professor, Faculty of Arts  
Department of Philosophy

Kankar Bhattacharya  
Professor, Faculty of Engineering  
Department of Electrical and Computer  
Engineering

Giovanni Cascante  
Professor, Faculty of Engineering  
Department of Civil and Environmental  
Engineering

Neil Craik  
Professor, Faculty of Environment  
School of Environment, Enterprise and  
Development

Olaf Weber  
Professor, Faculty of Environment  
School of Environment, Enterprise and  
Development

Maurice Dusseault  
Professor, Faculty of Science  
Department of Earth and Environmental  
Sciences

Jatin Nathwani  
Professor and Ontario Research Chair in  
Public Policy for Sustainable Energy  
Faculty of Engineering and Faculty of  
Environment

### UW WISE Members

#### FACULTY OF APPLIED HEALTH SCIENCES

**Philip Bigelow**, Associate Professor, Associate Director Graduate Research Programs, Public Health and Health Systems, University of Waterloo

#### FACULTY OF ARTS

**Paul Doherty**, Continuing Lecturer, Anthropology, University of Waterloo

**Heather Douglas**, Associate Professor, Philosophy, University of Waterloo

**Ranjini Jha**, Professor, School of Accounting and Finance, University of Waterloo

**Alain-Desire Nimubona**, Associate Professor, Economics, University of Waterloo

**Anindya Sen, Associate Professor**; Associate Chair, Graduate Studies, Economics, University of Waterloo

#### FACULTY OF ENGINEERING

**William Anderson**, Professor and Director of Admissions, Chemical Engineering, University of Waterloo

**Dipanjana Basu**, Associate Professor, Civil and Environmental Engineering, University of Waterloo

**Kankar Bhattacharya**, Professor, Electrical and Computer Engineering, University of Waterloo

**Paul Calamai**, Professor, Systems Design Engineering, University of Waterloo

**Claudio Cañizares**, Professor and HydroOne Endowed Chair, Electrical and Computer Engineering, University of Waterloo

## Section II: The Waterloo Institute for Sustainable Energy

**Giovanni Cascante**, Professor and Associate Chair, Graduate Studies, Civil and Environment Engineering, University of Waterloo

**Zhongwei Chen**, Assistant Professor, Chemical Engineering, University of Waterloo

**Pu Chen**, Professor, Chemical Engineering, University of Waterloo

**Chih Hsiung (Perry) Chou**, Canada Research Chair in Biomanufacturing and Editor of *Biotechnology Advances*; Professor, Chemical Engineering, University of Waterloo

**Michael Collins**, Associate Professor, Mechanical and Mechatronics Engineering, University of Waterloo

**James Craig**, Assistant Professor, Civil and Environmental Engineering, University of Waterloo

**Eric Croiset**, Professor, Chemical Engineering, University of Waterloo

**Cecile Devaud**, Associate Professor, Mechanical and Mechatronics Engineering, University of Waterloo

**Peter Douglas**, Associate Dean Undergraduate Studies and Professor; Chemical Engineering, University of Waterloo

**Ali Elkamel**, Professor, Chemical Engineering, University of Waterloo

**Ehab El-Saadany**, Professor and Tier 2 Canada Research Chair; Electrical & Computer Engineering, University of Waterloo

**Ramadan El-Shatshat**, Lecturer, Director of the Electric Power Engineering Program, Electrical and Computer Engineering, University of Waterloo

**Xianshe Feng**, Professor, Chemical Engineering, University of Waterloo

**Michael Fowler**, Associate Professor, Chemical Engineering, University of Waterloo

**Roydon Fraser**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo

**Mel Gabriel**, Adjunct Assistant Professor, Management Sciences/Applied Operations Research & Management of Technology, University of Waterloo

**Vincent Gaudet**, Professor, Electrical and Computer Engineering, University of Waterloo

**Bissan Ghaddar**, Assistant Professor and Adjunct Assistant Professor, Management Sciences, University of Waterloo

**Lukasz Golab**, Assistant Professor and Canada Research Chair, Management Sciences, University of Waterloo

**Wojciech Golab**, Assistant Professor, Electrical and Computer Engineering, University of Waterloo

**Irene Goldthorpe**, Assistant Professor, Electrical and Computer Engineering, University of Waterloo

**Jeff Gostick**, Assistant Professor, Chemical Engineering, University of Waterloo

**Robert Gracie**, Assistant Professor, Civil and Environmental Engineering, University of Waterloo

**Feridun Hamdullahpur**, University President and Vice-Chancellor; Professor, Mechanical and Mechatronics Engineering, University of Waterloo

**Keith Hipel**, Professor, Systems Design Engineering, University of Waterloo

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- Robert Hudgins**, Professor Emeritus, Chemical Engineering, University of Waterloo
- Shesha Jayaram**, Professor, Electrical and Computer Engineering, University of Waterloo
- Beth Jewkes**, Professor, Management Sciences, University of Waterloo
- David Johnson**, Associate Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Mehrdad Kazerani**, Professor, Electrical and Computer Engineering, University of Waterloo
- Behrad Khamesee**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Nasser Lashgarian Azad**, Associate Professor, Systems Design Engineering, University of Waterloo
- Hyung-Sool Lee**, Assistant Professor, Civil and Environmental Engineering, University of Waterloo
- Yuri Leonenko**, Associate Professor, Geological Engineering and Geography; Environmental Management, University of Waterloo
- Xianguo Li**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Yuning Li**, Associate Chair Graduate Studies and Professor, Chemical Engineering, University of Waterloo
- Fue-Sang Lien**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- David Mather**, Lecturer, Mechanical and Mechatronics Engineering, University of Waterloo
- John McPhee**, Professor, Systems Design Engineering, NSERC/Toyota/Maplesoft Industrial Research Chair, University of Waterloo
- Christine Moresoli**, Professor, Associate Dean Co-op Education & Professional Affairs, Chemical Engineering, University of Waterloo
- Sriram Narasimhan**, Assistant Professor, Canada Research Chair, Civil and Environmental Engineering, University of Waterloo
- Flora Ng**, Professor, Chemical Engineering, University of Waterloo
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- Mehrdad Pirnia**, Graduate Attributes Lecturer, Management Sciences, University of Waterloo
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- Garry Rempel**, Professor, Chemical Engineering, University of Waterloo
- Luis Ricardez-Sandoval**, Associate Professor, Chemical Engineering, University of Waterloo
- Catherine Rosenberg**, Professor and Tier 1 Canada Research Chair for the Future Internet, Electrical and Computer Engineering, University of Waterloo
- Rebecca Saari**, Assistant Professor, Civil and Environmental Engineering, University of Waterloo
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- Armaghan Salehian**, Associate Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Andrei Sazonov**, Associate Professor, Electrical and Computer Engineering, University of Waterloo
- Gerry Schneider**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Xuemin (Sherman) Shen**, Professor and University Research Chair, Electrical and Computer Engineering, University of Waterloo
- David Simakov**, Assistant Professor, Chemical Engineering, University of Waterloo
- John Simpson-Porco**, Assistant Professor, Electrical & Computer Engineering, University of Waterloo
- Siva Sivoththaman**, Professor and Ontario Research Chair, Electrical and Computer Engineering, University of Waterloo
- John Straube**, Associate Professor, Civil and Environmental Engineering, University of Waterloo
- Zhongchao Tan**, Associate Professor, Mechanical and Mechatronics Engineering; Civil and Environmental Engineering, University of Waterloo
- Susan Tighe**, Professor, Civil and Environmental Engineering, University of Waterloo
- Robert Varin**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Lan Wei**, Assistant Professor, Electrical and Computer Engineering, University of Waterloo
- John Wen**, Professor, Mechanical and Mechatronics Engineering, University of Waterloo
- Aiping Yu**, Assistant Professor, Chemical Engineering, University of Waterloo
- Jian Zhang**, Associate Professor, Bioreactor Engineering, East China University of Science and Technology
- Boxin Zhao**, Associate Professor, Chemical Engineering, University of Waterloo
- Weihua Zhuang**, Professor, Electrical & Computer Engineering, University of Waterloo
- Philip Beesley**, Professor, School of Architecture, University of Waterloo
- Terri Meyer-Boake**, Professor, School of Architecture, University of Waterloo

## FACULTY OF ENVIRONMENT

**Neil Craik**, Associate Professor, School of Environment, Enterprise and Development (SEED), University of Waterloo

**Robert Feick**, Associate Professor, School of Planning, University of Waterloo

**Komal Habib**, Assistant Professor, Industrial Ecology, University of Waterloo

**Jennifer Lynes**, Associate Professor, Program Director Environment and Business Undergraduate Program, Environment and Resource Studies, University of Waterloo

**Paul Parker**, Professor and Associate Dean, Strategic Initiatives, Geography and Environmental Management, University of Waterloo

**Ian Rowlands**, Professor and Associate Vice-President, International, School of Environment, Resources and Sustainability, University of Waterloo

**Olaf Weber**, Professor, School of Environment, Enterprise & Development (SEED), University of Waterloo

**Steven Young**, Associate Professor, School of Environment, Enterprise and Development (SEED), University of Waterloo

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**Ihab Ilyas**, Professor, Cheriton School of Computer Science, University of Waterloo

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## FACULTY OF SCIENCE

**Trevor Charles**, Professor, Associate Chair, Graduate Studies, Biology, University of Waterloo

**Maurice Dusseault**, Professor, Earth and Environmental Sciences, University of Waterloo

**Holger Kleinke**, Professor, Interim Executive Director, Chemistry, University of Waterloo

**Seyed Bijan Mahbaz**, Research Associate, Geomechanics Group, University of Waterloo

**Linda Nazar**, Professor, Chemistry, University of Waterloo

**Mark Pritzker**, Professor, Chemistry, University of Waterloo

**Eric Prouzet**, Associate Professor, Chemistry, University of Waterloo

**Pavle Radovanovic**, Professor, Chemistry, University of Waterloo

# 2.3 WISE BY THE NUMBERS

## Our People

**104** University of Waterloo Members

**145** AE4H Members

## Scholarly Output

**2,785** Publications

**772** Graduate Theses

## Industry – Academic Events

**24** Events and Workshops / **65** Public Lecture Series

**3,830** Registered Attendees / **86** Successful Funded Projects

## Secured Funding

**\$102.1 Million** Secured by WISE Faculty Members

**\$23.1 Million** Secured by WISE Management

2.4 Understanding our Members

## How Members Engage With WISE



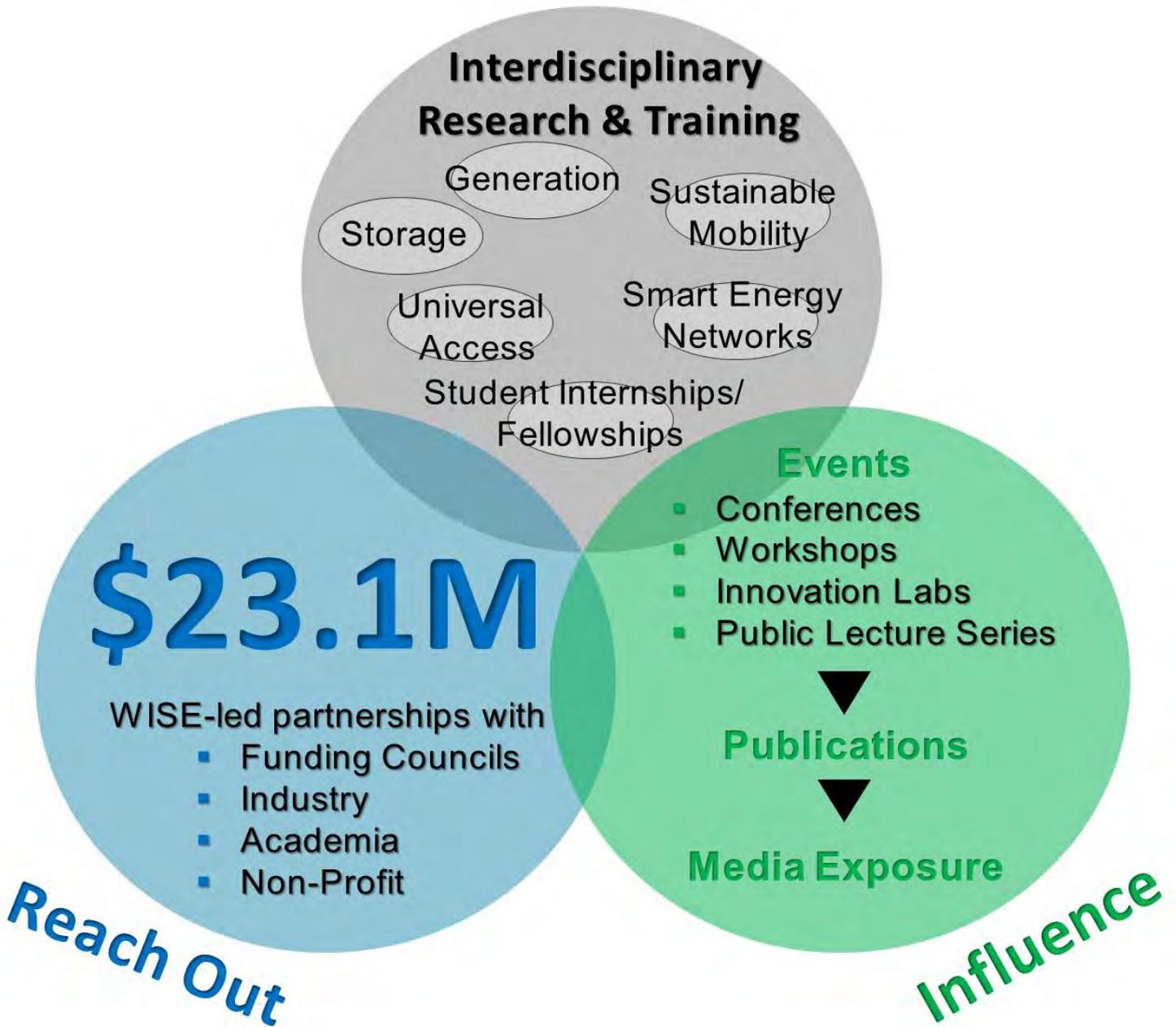
## What Faculty Value About Membership



Based on last survey (2018)

# **3. ACCOMPLISHMENTS AND IMPACT**

# Collaborate



## **3.1 Collaborate: Fostering Interdisciplinary Research and Training**

## **Collaborate:**

### **Fostering Interdisciplinary Research and Training**

Our research advances knowledge across several domains, informs energy policies, and helps put Waterloo centre-stage in the development of the clean energy economy.

WISE encourages interdisciplinary research collaboration on sustainable energy topics that range from technology through to economics and policy development. We are the central node that brings together over 100 WISE members from across all UW faculties and diverse departments to catalyze research collaboration on pressing energy sector challenges. We assist our members in acquiring funds and developing partnerships to support their research, disseminate the results of this work to key audiences both within and outside academia, and support the development of the next generation of sustainable energy leaders and change agents from the University of Waterloo. In a landscape that puts a premium on cross-disciplinary collaboration, WISE is the indispensable catalyst advancing sustainable energy research at UW.

In addition to supporting our members own research, WISE itself has championed a number of initiatives. Over the past five years, these have included a multi-million dollar research program to explore the feasibility of salt caverns as locations for compressed air energy storage, a variety of sustainable mobility initiatives related to electric vehicles and EV charging, industry-academia partnerships in the area of smart grids and smart energy networks, and a global initiative that catalyzes innovation in off-grid renewable energy technology to address the unmet energy needs of those living in energy poverty. Through these projects and others, WISE takes an active role in developing new opportunities to enhance UW's research excellence.

WISE recognizes the role of the University as an incubator for the next generation of energy sector leaders. WISE currently manages multiple externally funded programs that allow Waterloo's undergraduate, Masters and PhD students to conduct interdisciplinary research with a focus on sustainable energy and undertake internships with cutting edge sustainable energy enterprises within our network. WISE also responds to the growing prominence of entrepreneurship in the energy sector—and student interest in venture creation—through mentoring student teams and start-ups. We have been actively involved in on-campus social innovation competitions related to sustainable energy, and meet regularly with UW-based energy start-ups to provide them with advice and networking opportunities.



**“WISE has played an incredibly supportive role in my research in the last eight years. Indeed, I think that I could not do the work I am doing now if it were not for WISE.”**

Srinivasan Keshav  
Professor, ACM Fellow, IEEE Senior Member David R. Cheriton School of Computer Science

**“Since its inception, WISE has successfully brought together scores of academics and researchers from different departments, and faculties, and from Universities across the globe to collaborate under the umbrella of sustainable energy, and addressed diverse and critical issues.”**

Kankar Bhattacharya  
Professor, ECE Department  
Ph.D., P.Eng., FIEEE



**“WISE’s international, cross-discipline and collaborative approach to energy research promotes truly forward-thinking that is shaping the future of the electricity sector in Ontario.”**

Peter Gregg  
President and CEO  
Independent Electricity System Operator (IESO)

## 3.1.1 WISE Research

Between 2013 and 2018, WISE has played a pivotal role in developing research projects across a range of academic disciplines and knowledge domains. A variety of projects involving the WISE team and our members are described below, aligned in five primary domains: Energy Generation, Energy Storage, Smart Energy Networks, Sustainable Mobility, and Universal Energy Access.

### 3.1.1.1 ENERGY GENERATION

#### Solar

Over the past several years, the cost of solar energy systems and their components have declined by a large margin, paving the way to a cleaner, more sustainable energy future.

##### **FLEXIBLE SOLAR CELLS**

Conventional solar photovoltaic (PV) systems are being augmented by promising new materials and technologies. The possibility of using flexible large scale substrates opens the door to multiple advanced application opportunities such as smart textiles, photovoltaic window shades and options for building integrated solar technologies.

Research led by Professor Siva Sivoththaman (Electrical and Computer Engineering) is focused on graphene-decorated nanocomposites for printable electrodes in thin wafer devices for future solar cells. The synthesis of nanocomposites by incorporating graphene nanopowders as well as silver nanowires into epoxy-based electrically conductive adhesives (ECA) is being explored to improve electrical conductivity and to develop alternate printable electrode materials that induce less stress on the wafer. Low curing temperature, good thermal resistance, reasonably high conductivity, and low residual stress in the ECA/graphene nanocomposite makes this material a promising alternative in screenprinted electrode formation in thin substrates.

Professor Irene Goldthorpe (Electrical and Computer Engineering) has completed work on Al-doped ZnO/Ag-nanowire composite electrodes for flexible three-dimensional nanowire solar cells. The power conversion efficiency (PCE) of the three-dimensional solar cells improved by up to 60 per cent compared to using AZO electrodes alone due to enhanced coverage of the top electrode over the 3-D structures, decreasing the series resistance of the device by five times. The composite layer also showed a 10 times reduction in sheet resistance compared to the AZO thin-film contact under applied mechanical strain.

##### **NEXT GENERATION QUANTUM DOT TECHNOLOGY**

Solar PV Quantum dots (QDs) are semi-conductors on a nanometer scale. They are an emerging class of functional material being developed for novel solar energy conversion strategies. First and second generation PV cells have best-cell PCEs that are asymptotically approaching the Shockley-Queisser (SQ) limit; for example, the record for c-Si based solar cells is currently at 25 per cent, while for GaAs the record is 28.3 per cent. Third generation PV can have a higher limiting conversion efficiency through bypassing one of the assumptions of the SQ analysis and recovering either some of the

energy lost via thermalization or providing pathways to harvest those photons not absorbed in a standard solar cell. In addition to the efficiency considerations, third generation solar cells promise low manufacturing costs.

Professor Sivoththaman's team has examined the toxicity and safety aspects of nanoparticle spread in third generation photovoltaic device processing environments. Detection of aerosolized nanoparticles was experimentally verified using gold nanoparticle adsorbent, followed by spectroscopic measurements. Results from in-vitro cytotoxicity study with HeLa cell cultures and fluorescent plate reading confirms that core/shell 'CdSe/ZnS' QDs are responsible for cell death following exposure.

### **SOLAR ROADWAYS**

Professor Susan Tighe (Civil and Environmental Engineering) has conducted a finite element analysis to predict how her solar road based prototype would perform in real-world conditions. Using modelling software, her team tested the panel's durability on four structural bases typically used in Ontario pavement: concrete, asphalt, granular and subgrade. For each, they applied the maximum wheel and axle loads allowed under Canadian regulations to different areas on the panels, checking whether they would crack or fail under the pressure.

In all cases, there were no cracks and the strain put on the transparent and base layers of the panels fell well below their endurance limits, demonstrating that the prototype is road-worthy.

Additional reinforcement provided by the solar panels helped distribute tire loads, actually maintaining or improving the structural performance of the base they're installed on. The results suggest that researchers can move their trials out of the lab and into the field – paving the way for a network of solar highways.

## **WIND**

The role of wind power in the reduction of CO<sub>2</sub> emissions is well recognized. Wind power generation has shown remarkable growth worldwide and in Canada with generation capacity increasing dramatically over the past decade.

### **WIND POWER FORECASTING**

One of the challenges for wind farm operators is to determine the amount of electricity that can be produced by wind turbines on any given day to meet the desired energy demand as wind speeds vary from hour to hour.

Professor Fue-Sang Lien (Mechanical and Mechatronics Engineering) and his team of graduate students have developed a model for feeding the best statistical and meteorological data into an interconnected framework of artificial neural networks to forecast wind speed and turbine power. The result is an advanced 72 hour accurate forecast that will help operators and utilities to manage the power supply more efficiently.

### **WIND TURBINE PERFORMANCE ANALYSIS**

Wind turbines frequently operate in multifaceted atmospheric conditions due to continually changing wind direction and magnitude. These conditions can impact the performance of the wind turbines due to unstable airloads on the blades that can result

in turbine rotors that are misaligned with the wind (yawed). Prof. David Johnson (Mechanical and Mechatronics Engineering) and his group are analyzing different technical parameters of various blade designs by studying the wind turbine rotor under yaw loads.

## **HEALTH AND SOCIAL CHALLENGES OF WIND FARMS**

Challenging issues for social and community acceptance of wind power development include noise and suspicion of negative health impacts. To meet regulatory requirements for noise levels, new predictive tools are required in support of new wind farm development.

Professor Johnson has developed tools based on computational fluid dynamics studies to predict the far field sound. Validation of these predictive tools with experimental measurements of 2D airfoil self-noise measurements obtained at the University of Waterloo Wind Energy Research wind turbine field site shows good agreement with the measured experimental data. Professor Johnson also contributed to the Canadian Council of Academies Expert Panel on Wind Turbine Noise and Human Health, which published its report in 2015.

Professor Lien and his team of graduate students have also investigated noise emission and the power output from a small horizontal axis wind turbine by using coarse-resolution computational fluid dynamics (CFD) simulations. Professor Lien's team has shown that a computational modeling/simulation framework involving coupled aerodynamic and aero-acoustic components can be used to address a specific industrial challenge: namely, a physics-based prediction of the noise generated by a full scale wind turbine.

## **Geothermal**

### **INTERMEDIATE GRADE GEOTHERMAL ENERGY**

Intermediate grade geothermal energy is an abundant, low carbon base load energy source that does not require high temperature gradients or heat sources and can be extracted by using the latest drilling technology at an affordable cost. The typical range of intermediate grade geothermal energy is 80-150°C found several kilometers beneath the Earth's surface.

Professors Dipanjan Basu (Civil and Environmental Engineering), Roydon Fraser (Mechanical and Mechatronics Engineering), and Maurice Dusseault (Earth and Environmental Science) have collaborated to assess the geothermal resources in Canada with an eye to harvesting this energy.

Geothermal has emerged as a significant carbon-free energy resource to help Canada transition towards a low carbon energy economy consistent with Canada's international obligations to reduce the GHG emissions for meeting the climate challenge. Geothermal energy is a ubiquitous energy resource that can provide a continuous – non intermittent – source of base load electricity or heating to meet end user requirements. Geothermal energy's positive environmental attributes –low GHG emissions and low water usage requirements as part of closed cycle configurations – coupled with the potential for meeting energy requirements in northern Canada and to serve distant isolated communities is another strategic advantage. If geothermal energy resource is developed to it fullest potential to serve a wide range of end user requirements across a range of

geothermal technology options, then its strategic national importance lies within three intersecting goals: environmental sustainability, economic prosperity through a transition from fossil fuel extraction to direct heat and electricity extraction and reduction of dependence on foreign energy resources.

WISE has been also instrumental in providing leadership to two major global energy summits in co-operation with the Waterloo Global Science Initiative (a partnership of UW and the Perimeter Institute. WGSi's first major report – The 'Equinox Energy 2030 Blueprint' (2012) – specifically identified advancement of geothermal energy as a credible pathway for an energy future without fossil fuels. A second Summit produced the OpenAccess Energy Blueprint – which identified remote off-grid communities in Canada as potential sites for geothermal energy deployment. WISE has therefore made specific efforts to advance geothermal research at UW over the past 5 years, in accordance with the opportunities identified at the WGSi summits, and engaged consistently with a variety of emerging sector players from across the country, including through hosting a geothermal symposium event in Waterloo to advance national-level collaboration.

### **GROUND SOURCE HEAT PUMP SYSTEMS**

Ground Source Heat Pump Systems (GSHPs) are among the most efficient and sustainable methods to provide space heating, cooling, and hot water to residential and commercial buildings. The technology has a great potential to reduce carbon emissions and address energy demands of the different dwelling types in Canada by delivering energy access to residential and commercial buildings at a low cost. Prof. Basu leads the project to identify the technical constraints and to perform a detailed life cycle assessment of GSHPs in Northern Ontario.

### **GEOHERMAL PILE FOUNDATIONS**

Prof. Basu is also investigating the feasibility of using helical piles to extract shallow geothermal energy. These pre-fabricated piles can be quickly installed under a variety of subsurface conditions, and are attractive foundation option for 1-3 storey residential buildings. However, these piles have never been used to extract shallow geothermal energy from the ground. If successful, geothermal helical piles will be cost-effective building solution that serves the dual purpose of providing structural support and providing space heating, cooling, and hot water to a variety of residential buildings.

This technology will not only help in reducing the carbon footprint of future building stock but also minimize the energy expenditure for consumers. In this technology, energy is extracted from the ground when in heating mode, and energy is released to the ground when in cooling mode.

## **Bioenergy**

Bioenergy has the potential to make an important contribution to meeting growth in energy demand in an environmentally responsible manner, while at the same time providing opportunities for social and economic development in rural communities.

## **THERMAL AND THERMOCHEMICAL TECHNOLOGIES**

A thermal conversion is the use of heat, with or without the presence of oxygen, to convert biomass materials or feedstocks into other forms of energy. Thermal conversion technologies include direct combustion, pyrolysis, and torrefaction. A key thermochemical conversion process is gasification.

Professors Ali Elkamel and William Anderson (Chemical Engineering) are developing a conceptual design of a peat gasification process to produce electricity and methanol. Two types of gasifiers (updraft fixed-bed and dual fluidized-bed) and two types of methanol synthesis reactors (gas-phase and liquid-phase) are paired to create four design alternatives that are modeled through this research. The chosen design is then refined with detailed modeling of the power generation section and energy integration. The final design consumes 1,000 tonne peat/day, produces 214 tonne methanol/day, and generates 56 MW of electricity with GHG emissions reduced by 22 per cent compared with traditional alternatives.

## **BIOLOGICAL AND BIOCHEMICAL TECHNOLOGIES**

Micro-organisms can be regarded as biochemical “factories” for the treatment and conversion of biological materials. Fermentation technologies, with the assistance of biological engineering, are leading to breakthrough processes for creating fuels and fertilizer, and other products useful in agriculture and the energy sector.

Research conducted by Professor Hyung-Sool Lee (Civil and Environmental Engineering) involves production of hydrogen from sugar beet juice using an integrated biohydrogen process of dark fermentation and microbial electrolysis. Professor Lee is also focusing on the concept of microbial fuel cells with emphasis on three key areas: (i) Adding an electron scavenger to the system to prevent the efficiency drop that occurs when the electrons produced from bacteria are grabbed on route to the anode, (ii) Using large quantities of *Geobactersp.* to increase the current density within the fuel cells, and (iii) Reducing the internal resistance by designing fuel cells with a high surface-to-volume ratio and adjusting the distance between electrodes.

Professor Flora Ng (Chemical Engineering) has turned to acid catalysts to create a cost-effective and green alternative. She is performing several analytical studies to evaluate the feasibility of producing biodiesel from high-FFA (free fatty acids) feedstock without the problem of soap by-products by using a novel solid acid catalyst and converting the oil's triglycerides and FFAs into biodiesel in a single-step process. One of her key focused areas is to produce biodiesel with glyceride levels and acid numbers that met international biodiesel standards by adding a water-stripping step.

## **Piezoelectricity**

Piezoelectric energy harvesting is a groundbreaking technology that can be used to transfer energy wirelessly from one location to another. This is a method of capturing minute amounts of energy in the form of heat, light, sound, vibrations, and electromagnetic fields. Such electromagnetic energy is abundantly available from sunlight, radio waves, and infrared radiation.

## **ELECTROMAGNETIC ENERGY WIRELESS TRANSFER**

Professor Omar Ramahi (Electrical and Computer Engineering) and his team have proposed the concept of etching to harvest up to 97 per cent of the electromagnetic energy that falls onto the surface of sheets of copper by etching repeating patterns on a sheet of metamaterial and adjusting the dimensions of the patterns. The ultra-efficiency of the process makes it a potential low cost option for energy harvesting.

### **PIEZOELECTRIC MICROELECTROMECHANICAL SYSTEMS (MEMS)**

The goal of MEMS is to create a self-sustainable integrated system for smart grid monitoring and active management of electrical demand. In this way, issues related to grid capacity, reliability and efficient distribution of power can be monitored and controlled through sensing units as they have the capability to measure current and identify failures across the grid.

Compared with the traditional technology, the MEMS technological concept is highly competitive due to its non-invasive properties, low maintenance and significantly reduced costs. Professor Armaghan Salehian (Mechanical and Mechatronics Engineering) and her research team are developing a system-on-chip solution to monitor electric power in smart grids using a piezoelectric based MEMS current sensor. In addition to a much smaller footprint, once developed, the proposed technology will have many advantages over its opponents in the market including superior accuracy for high current measurements — a limitation for available technologies due to their saturation problems.

## **Carbon Dioxide Capture and Storage**

Carbon dioxide capture and storage (CCS) technologies are an attractive option to limit CO<sub>2</sub> emissions from fossil fuel power plants. If the technology can be developed cost-effectively, CCS can be a vital tool in mitigating meeting the goals of greenhouse gas (GHG) emissions from the power sector and large industrial operations.

### **CO<sub>2</sub> CAPTURE FROM COAL-FIRED POWER PLANTS**

Professors Eric Croiset, Peter Douglas, and Luis Ricardez-Sandoval's (Chemical Engineering) research includes dynamic modelling of a CO<sub>2</sub> capture and purification unit for an oxy-coal-fired power plant. They have concluded that oxy-combustion is a promising pathway to capture CO<sub>2</sub> from coal fired power plants and can compete favourably with other CO<sub>2</sub> capture technology pathways, such as post-combustion and pre-combustion. Future research will focus on validating a dynamic model of the CO<sub>2</sub>CPU for control design purposes.

Professors Croiset, Douglas, and Elkamel have also collaborated on a project using short-term resource scheduling for assessing effectiveness of CCS within the electricity generation subsector.

## 3.1.1.2 ENERGY STORAGE

### THE NEED FOR STORAGE

Energy storage technologies provide valuable support to power grids as backup power, load leveling, frequency and voltage regulation, and energy management services. Rapid development of variable renewable energy resources (wind and solar in particular) suggests a growing role for storage to accommodate the intermittency of generation. The need for balancing services, rapid generation ramping, and moving energy from times of excess to times of high demand are expected to increase with high levels of wind and solar energy penetration. Practical energy storage solutions comprise a range of technologies: electrochemical (batteries and capacitors), compressed air, pumped hydro and indirect options such as power-to-gas and hydrogen.

### BATTERY STORAGE

Batteries can play a significant role in managing variability and supporting the decentralized nature of renewable energy technologies to ensure a reliable electricity supply. At high levels of penetration, the fluctuations of energy output increases the risk for reliable operation of the grid. The physics of power flows requires supply and demand of electricity must be balanced at all times. This storage technology can be used for both short (seconds-minutes) and long-term (hours-seasons) applications, and benefits from being highly scalable and efficient.

Battery storage in the power sector needs to overcome several barriers before it can be integrated as a mainstream option. One barrier is the lack of monetary compensation schemes available for the benefits of battery storage systems. Cost competitiveness, validated performance, regulatory hurdles, and safety are others.

Professor Linda Nazar (Chemistry) has made significant advances on the characterization techniques commonly employed for battery evaluation. The recent work is a study of methods and protocols for electrochemical energy storage materials. This project involves a comprehensive analysis of electrode preparation, coin cell assembly, electrochemical evaluation techniques, operando X-ray diffraction, operando pair distribution function analysis, operando X-ray absorption spectroscopy, and X-ray photoelectron spectroscopy techniques. Professor Nazar was named an Officer for the Order of Canada in recognition of her excellence in research. She holds the Canada Research Chair in Solid State Energy Materials, and is a Fellow of the Royal Society of Canada.

Professor Nazar has also developed a concept for aqueous batteries to provide cost-effective, durable, and safe options to battery storage. Utilizing zinc as the negative electrode addresses the issues of low energy density, slow charge and discharge speeds and inability to hold a charge over many cycles. Other issues have been tackled by building a better positive electrode. Professor Nazar and her team has created nanobelts of vanadium oxide bronze with metal ions and structural water sandwiched between sheets of oxide. The result is a compact electrode structure that allows aqueous batteries to charge and discharge quickly and this technology retains more than 80 per cent of its capacity over 1,000 cycles. The nanobelts are also easy to fabricate on a large scale. At a cost of less than US\$65 per kilowatt-hour, these batteries offer a highly affordable solution for grid-scale storage.

Professor Zhongwei Chen (Chemical Engineering) is working on an anode material that can maximize the performance of a lithium ion battery (LIB) in energy storage options. LIB can play a vital role as renewable energy storage devices for applications in electric vehicles and portable electronics. Currently, lithium-ion batteries are extensively employed in portable electronic devices with their expanded applications has expanded to the electric vehicle market. Battery technologies beyond Li-ion batteries, such as lithium-sulfur (Li-S), sodium-ion (Na-ion), and magnesium (Mg) batteries, have gained much attention from the research communities and industry as they offer advantages for sustainability, cost-effectiveness and high capacity performance. Commercial LIBs employ graphite as the anode material with a low capacity unable to satisfy the energy demand of emergent systems. There is a need to develop new anode materials with high capacity and reliability as well as low fabrication cost for practical applications. LIBs that utilize the anode material developed by Prof. Chen and his team can deliver a high volumetric capacity and exhibit superior cycle stability over 1500 cycles as well as a high capacity retention of 85%. Excellent battery performance combined with the simplistic, scalable, green chemistry approach makes this material a promising candidate for LIB applications.

### COMPRESSED AIR ENERGY STORAGE

Solar and wind energy are increasingly being integrated into power grids, however, their intermittent and variable nature of output requires large-scale (gigawatt-level), cost-effective storage to help balance local and regional generation sources to enable a larger share of renewable energy generation into the power grid.

Compressed Air Energy Storage (CAES) is a solution that offers a variety of socio-economic and environmental benefits for the energy economy as a whole. The CAES storage reservoir can be constructed in pre-existing formations i.e. salt caverns, aquifers and abandoned mines. As a result, the capital cost of adding an incremental amount of storage capacity can be much lower than for other comparable storage technologies. Not only is CAES financially practical for bulk storage, it is a promising storage solution that:

- **Accommodates Large Scale Integrated Renewables** through the ability to store and combine intermittent solar and wind power in underground salt caverns
- **Enhances Grid Performance** by providing stability, reliability, and additional peak capacity to the grid infrastructure
- **Leads to Environmental Sustainability** by maximizing environmentally friendly forms of electricity generation
- **Contributes to Economic Benefits** since this technology would allow cost effective operation of wind resources when demand during the night is low

CAES leverages the geological advantage of salt caverns in both provinces to provide cost-effective energy storage on a large scale to facilitate renewables integration, improve grid stability and resiliency, reduce cost of new generation and transmission, deliver economic value to different types of industry stakeholders, and enable the provinces to meet and exceed sustainability targets, through integration with existing and next generation turbines and innovative grid management techniques.

Over the past three years, WISE has taken on an ambitious project to assess and deploy CAES technology in Canada. This work is led by Professor Dusseault, Professor Fraser and Professor Giovanni Cascante (Civil and Environmental Engineering), along with a team of investigators from the University of Waterloo, including Prof. Basu and Profs. Claudio Cañizares and Kankar Bhattacharya (Electrical and Computer Engineering),

Jatin Nathwani (WISE), researchers from the University of Alberta and the University of Calgary, and industry partners including Hydro One Networks Inc., Ontario Power Generation (OPG), Union Gas Limited, NRStor Inc., Compass Minerals and Rocky Mountain Power (RMP)

An initial assessment showed that CAES in salt caverns is a technically feasible and financially viable technology. In addition, it is concluded that CAES integrates well with battery energy storage because they occupy different response-time regions and are of different scales of output over demand times (seconds to days).

Following this assessment, WISE partnered with NRStor and Hydrostor to initiate Canada's first CAES in Salt Caverns project in the city of Goderich, Ontario. This \$7.2 million CAES facility has a planned installed capacity of 1.75 MW (7MWh) and will be operating under a contract with the Independent Electricity System Operator (IESO). In addition, NRStor Goderich intends to provide energy and operating reserve services to the IESO markets. This project is expected to be the world's first commercial fuel-free CAES facility when completed.

## **FLYWHEELS**

Flywheel energy storage systems (FESS) offer several unique advantages as an energy storage solution with attributes of a high cycle life, long operational life, high round-trip efficiency, high power density, low environmental impact, and ability to store megajoule (MJ) levels of energy with no upper limits when configured in banks.

Flywheels are mechanical devices that spin at high speeds, storing electricity as rotational energy. This energy is later released by slowing down the flywheel's rotor, releasing quick bursts of energy (i.e. releases of high power and short duration).

Professor Magdy Salama (Electrical and Computer Engineering) and his team have proposed a unique approach, using a flywheel to store excess electricity during off-peak periods and also reduce voltage fluctuations. The system consists of a flywheel, a permanent magnet synchronous machine and three-phase back-to-back converters. The researchers put it to the test in a simulation of a residential distribution network that includes photovoltaic panels. The results show that incorporating a flywheel energy storage system can compensate for the fluctuations in output power, thus reducing the need for an automatic voltage regulator. Thus, more electricity produced by solar panels is actually used, extracting maximum benefit from each ray of sunshine.

## **HYDROGEN 'POWER-TO-GAS' TECHNOLOGIES**

Hydrogen-based energy storage technologies show tremendous potential across a variety of applications, but face significant challenges related to the design of efficient and low-cost hydrogen production, transmission and storage technologies.

Professors Michael Fowler and Ali Elkamel (Chemical Engineering) are developing strategies to decarbonize transportation through the use of power-to-gas. Power-to-Gas is a technology that generates hydrogen by electrolysis. It can be used to provide a number of energy services including energy storage, ancillary services for the electrical grid and, the production of hydrogen for industrial processes and transportation fuel. The purpose of this work is to provide an incentive for using power-to-gas technology for oil refining processes in an effort to reduce the carbon footprint in refining industry and ultimately the transportation sector.

This work also highlights the optimal size and operation of hydrogen production facilities that include polymer electrolyte membrane (PEM) electrolyzers to meet the proposed refinery demand. The researchers note that power-to-gas is an economically feasible approach to produce hydrogen. The use of PEM electrolysis to provide hydrogen results in a significant reduction of emissions.

### **BUSINESS MODELS FOR GRID-SCALE STORAGE**

The choice of appropriate business model, complexity of regulatory and policy environment, ownership and governance structure of storage assets, financing strategies, managing revenue streams, and associated operational risks are critical for providing an accurate assessment of the viability of the emerging energy storage technologies.

Professor Nathwani and doctoral student Kourosh Malek have developed a typology of business models by employing a set of technology management frameworks in the context of energy storage technologies for power grid applications. The business model framework is tailored to provide a customized analysis platform for adopting emerging energy storage technologies. Several case studies were undertaken to validate the business model framework and the energy storage valuation analysis. For industry looking to adapt new energy storage technologies, this analysis provides unique insights through a multi-dimensional considerations of cost, efficiency, reliability, best practices and policy instruments.

### **3.1.1.3 SMART ENERGY NETWORKS**

A smart energy network (SEN) uses clean energy technologies coupled with information and communication technologies (ICT) to improve the reliability and cost performance of the overall systems. SENs allow integration of all available energy sources, including electricity, natural gas, heat, bioenergy, solar PV, wind, geothermal, and storage.

The value proposition of smart energy networks relies on the integration of disparate and diverse components through ICT. The potential and promise of ICTs utilizing big data to enable optimal performance of a networks is a focus of extensive research activity at WISE. Convergence of ICT with multiple networks including sustainable mobility and transportation offers the potential for large benefits to consumers if demand and supply can be matched through real-time feedback. Eliminating or reducing the demand for services at peak times allows flexibility in the planning and operation of the infrastructure and helps achieve a lower societal cost.

### **CANADIAN LEADERSHIP IN SENs RESEARCH AND SMART GRID TECHNOLOGY**

The electricity grid is a complex web of interconnected physical systems that comprise the generation, transmission, and distribution infrastructure. It is an ecosystem of asset owners, manufacturers, service providers, consumers, prosumers and diverse stakeholders. To modernize the grid is to make it “smarter” and more resilient through the use of cutting-edge technologies, equipment, and controls that communicate and work together to deliver electricity more reliably and efficiently.

Smart grids are a key enabler for consumers and businesses to better manage their own energy consumption and costs through easier access to data. Utilities also benefit from

a modernized grid, including improved security, reduced peak loads, increased integration of renewables, and lower operational costs.

In the fall of 2003, WISE members, led by Prof. Nathwani, were joined by 65 leaders in government, utilities, business, civil society and academia to initiate a discussion about the potential role of integrated, multiple-fuel, and communicative systems in Canada's energy future. The event marked the beginning of a long history of WISE activities to pioneer the concept and advance SENs in Canada.

Pioneering work has been initiated by Professors Croiset, Elkamel, and Douglas (Chemical Engineering), who have undertaken a collaboration with Union Gas, Horizon Utilities, Natural Resources Canada (NRCan), Canadian Gas Association (CGA), Canadian Electricity Association (CEA), Continental Automated Buildings Association (CABA), National Research Council (NRC) of Canada, and Quality Urban Energy Systems of Tomorrow (QUEST) to develop an extensive set of smart energy network models available for application on demonstration projects.

Professors Ian Rowlands and Paul Parker (Faculty of Environment) with Professors Cañizares and Bhattacharya (Electrical and Computer Engineering) have completed a major project on the 'Energy Hub Management System' (EHMS). The EHMS portal allows real-time management of energy demand, production, storage and import and export from different locations and types of facilities such as manufacturing, farm, retail stores and residential homes.

Professor John Simpson-Porco (Electrical and Computer Engineering) has also developed a 'plug and play' form of decentralized control by adding a distributed averaging proportional-integral (DAPI) controller that makes micro-grid more stable — and in the process enhances the integration of renewable energy resources.

Professor Cañizares and Bhattacharya work on the development of a freeware Smart Residential Load Simulator facilitates the study of residential energy management systems in smart grids. The tool provides a complete set of user-friendly graphical interfaces to model and study smart thermostats, air conditioners, furnaces, and household appliances. Wind and solar power generation as well as battery sources are also modeled allowing impact of different variables such as ambient temperature and household activity levels to be quantified for optimal use of energy. The simulator enhances understanding of how these contribute to peak demand, providing individual and total energy consumption and costs. This freeware platform is a useful tool for researchers and educators to validate and demonstrate models for energy management and optimization, and can also be used by residential customers to model and understand energy consumption profiles in households.

Professor Salama's novel incentive-based distribution system expansion planning (IDSEP) model enables an LDC and distributed generation (DG) investors to work in a collaborative way for mutual benefit. Using the proposed model, the LDC would establish a bus-wise incentive program (BWIP) based on long-term contracts, which encourage DG investors to integrate their projects at specific system buses to benefit both parties. The model guarantees that the LDC will incur minimum expansion and operation costs while concurrently ensuring the feasibility of DG investors' projects. The intermittent nature of both system demand and wind- and PV-based DG output power is handled probabilistically, and a number of DG technologies are taken into account.

Dr. Kumaraswamy Ponnambalam (Systems Design Engineering) and Dr. Ehab El-Saadany (Electrical and Computer Engineering) have developed a two-stage stochastic centralized dispatch scheme for AC/DC hybrid smart grids to reduce the expected high operating cost while satisfying the operational and technical constraints of interaction among several components of smart grid. The scheme will coordinate the operations of a number of distributed energy resources (DERs) and ensures the harmonized charging of EVs and models to address degradation of batteries over time. The approach, if successful, will also solve scheduling problems associated with an intermittent supply, variable demand and fluctuating real time energy pricing issues.

Professors Sherman Shen and Kankar Bhattacharya (Electrical and Computer Engineering) are working on areas of Information and Communications Technologies (ICT) in Smart Grid applications that will result in significant benefits to Canadian users and will foster a vital competitive edge to Canadian ICT and power industries in the international market place. The end goal is to develop innovative information and communication solutions for the smart power grid in order to facilitate integration of renewable energy sources and energy storage devices in microgrids, planning of electric vehicle (EV) charging infrastructure including vehicle-to-grid (V2G) systems to balance power generation and demand. In addition, novel cyber-physical security and customer privacy protection techniques will be developed to enhance smart grid communications. The research outcomes will help to increase the market share of renewable energy in Canada.

Professor Nathwani, as a founding member for the Ontario Smart Grid Forum (chaired by the IESO and now renamed the Energy Transformation Network Ontario) has been an active contributor since 2008 to the development of legislation, government policy, and the support of innovation for Smart grid technologies in Ontario.

#### **THE 'INTERNET OF THINGS' AND THE 'INTERNET OF ENERGY'**

The Internet of Things (IOT) is a network of interoperable embedded sensors, computers and communication devices that enrich and transform the way energy is generated, transmitted, distributed, and delivered to the end user. The internet of energy (IOE) represents a new reality in the energy sector with significant potential for disruption of the existing business models of the distribution. The interactions of ubiquitous sensors, devices, and diversity of systems allowing real-time decisions by many participants has the benefit of enhancing efficiency, effectiveness and productivity of the entire energy supply chain and this shifts control from producers to users.

Professors Catherine Rosenberg (Electrical and Computer Engineering) and Srinivasan Keshav (Cheriton School of Computer Science) continue to advance their research in low power connected devices (sensors, actuators); use of an energy storage system (ESS) to integrate solar energy generators into the electrical grid; designing and operation of hybrid energy storage systems; developing practical strategies for storage operation in energy systems; interaction between personal comfort systems and centralized HVAC systems in office buildings; multiple time-scale model predictive control for thermal comfort in buildings; integration of renewable generation and elastic loads into distribution grids; and optimal design of solar PV farms with storage.

A number of IoE research initiatives are being advanced at WISE, including:

- Low power connected devices (sensors, actuators)

- Use of an energy storage system (ESS) to integrate solar energy generators into the electrical grid
- Developing practical strategies for storage operation in energy systems
- Interaction between personal comfort systems and centralized Heating, Ventilation and Air Conditioning (HVAC) systems in office buildings
- Multiple time-scale model predictive control for thermal comfort in buildings
- Integration of renewable generation and elastic loads into distribution grids

The objective of this research is to develop innovative information and communication solutions that facilitate integration of renewable energy sources and energy storage devices in smart-grids and micro-grids. In addition, novel cyber physical security and customer privacy protection techniques, and peer-to-peer energy sharing schemes are being explored to enhance smart grid efficiency and communications.

In addition, Professor Rosenberg, in collaboration with Professor Abinav Kumar (IIT, Hyderabad, India), have developed a project on 'Energy and Throughput Trade-Offs in Cellular Networks Using Base Station Switching'. The information and communication technology (ICT) sector is responsible for approximately two per cent of the global CO<sub>2</sub> emissions. Within ICT, cellular networks are one of the biggest contributors. Base stations (BSs) operations consume up to 80 per cent of the energy required for the operation of a cellular network. The research highlighting a complex interplay between coverage, power management, scheduling, and interference and recommendations are developed to take into account a strategy for saving energy to enable base station switching.

### **ARCHITECTURE OF 5G NETWORKS IN THE POWER SECTOR**

5G Technology is the fifth Generation Mobile technology. 5G technology has the potential to unleash the next wave of smart grid or "intelligent" features to improve efficiency and cost performance. By allowing many unconnected, energy consuming devices to be integrated into the grid through low-cost connections, 5G enables these devices to be more accurately monitored to support better forecasting of energy needs. By connecting these devices using a smart grid, demand side management can be enhanced to support load balancing, helping reduce electricity peaks and ultimately reduce energy costs. Capturing this data through 5G connections will further enable large cities with high density urban growth to plan for energy infrastructure spending more efficiently and reduce downtime.

The business potential of introducing 5G in the energy domain is exceptionally high; it provides support not only to the critical machine type communication (MTC) applications of energy grid protection and control, but also to the massive volume of MTC type applications of the emerging smart metering data. The ongoing evolution of the power grid into a grid supporting a much more distributed generation and storage of power as well as micro-grids would be a clear beneficiary of the high performance with a very flexible communication architecture provided by 5G.

Professor Rosenberg, Cisco Research Chair in 5G Systems, is leading a multidisciplinary team of experts to help the industry leaders to prepare for the introduction of 5G. She will be working on a family of 5G technologies related to new frequency bands, which will enable faster data transfer and reduced delays for greatly improved wireless service.

## **REGIONAL ENERGY HUBS AND TRADING**

Greater optimization of underutilized generation capacities over a wide geographic area through additional transmission interconnectors can support emissions reduction and energy transition strategies across several independent jurisdictions and countries. Transmission investment, however, is not explicitly identified as a powerful enabler of global energy transitions within the compass of clean energy policy debates.

Professor Nathwani and Post doctoral fellow Dr Burak Guler have argued for larger investments to be made in transmission capacity that allow greater inter-regional electricity trade through grid development on a continent wide basis. This will allow more effective and lower cost fuel switching among countries through a physically connected market. A conceptual framework of “Regional Energy Hubs” has been developed including a cost minimization model in support of a transmission investment strategy that integrates several key factors including geography, economics, and environmental factors.

## **BLOCKCHAIN FOR THE ENERGY SECTOR**

Blockchain applications have the potential to create substantial new value in the energy sector. The blockchain ledger is currently used to reduce transaction costs, pinpoint origins of energy, increase the efficiency of exchanges, and maintain more proficient records. This technology also gives consumers the opportunity of distinguishing where energy is coming from – renewables or traditional fossil fuel based power generating plants. In the past, electric grids used to measure electricity as net amounts and don't allow consumers to pick and choose. Now, the consumers are empowered to choose their preferred energy generation option and switch providers. The technology overcomes a process that is currently full of technical and financial constraints.

Professor Keshav and colleagues have developed a prototype blockchain solution called Canopus with capability of handling more than one million transactions per second in support of the Renewable Energy Certificates (REC) trading. The goal is to reduce the cost of certification, eliminate onerous auditing and avoid non-market price controls, so that even a small-scale green generator could de-risk investments. Today's blockchains cannot support the addition of more than a few hundred certificates or trades (we can call them both “transactions”) per second. This is because blockchain servers require agreement on the contents of each block with endemic server and communication failures and the presence of malicious servers. This is known as the difficult “consensus problem.”

Currently, BitCoin, the best-known blockchain, supports only about 10 transactions per second and HyperLedger, IBM's competing solution, under 1,000 transactions per second. Professor Keshav's Canopus prototype takes a server's location on the internet cloud into account, minimizing communication between geographically distant servers.

By keeping most communications local and fast, blockchain servers can process far more transaction records each second than a traditional consensus protocol that doesn't take location into account. This improvement in scaling allows even mom-and-pop green generators to obtain certificates and participate in energy transactions. In long term, this work will encourage homeowners and small businesses to invest in renewable energy technologies to become green generators. It would also encourage Ontario's electricity consumers to become 100 per cent green.

### 3.1.1.4 SUSTAINABLE MOBILITY

Electric Vehicles (EVs) are increasingly recognized as a viable transport alternative to internal combustion gasoline engines. The Canadian government has created incentives and policies in support of EVs and deployment of EV charging infrastructure. However, the sporadic growth of the EV industry has given rise to numerous technical challenges, and may create challenges for the operation of energy distribution systems.

At WISE, more than two dozen members conduct research involving electric vehicles. Their objectives are to develop innovations to enhance the performance of EVs and improve their component technologies, as well as to scope and address challenges related to augmented demand for electricity resulting from increased penetration of EVs.

#### VEHICLE TO GRID TECHNOLOGIES

The term “vehicle-to-grid” describes the use of car batteries as a source of power that can be used for grid services, such as frequency regulation when the car is not in the drive mode. The idea has significant appeal because the battery capacity of electric vehicles is not in use for 95 per cent of the time. The goal is to “develop driver-centered business models” to support a rapid roll out of vehicle-to-grid (V2G) technologies, allowing millions of electric car batteries to become a vital part of the power grid.

WISE researchers are actively involved in addressing challenges and opportunities that arise when EVs become part of the electricity grid.

Professors Sherman Shen and Weihua Zhuang (Electrical and Computer Engineering) work on electric vehicle integration and Vehicle-to-Grid (V2G) system optimization which has the potential to revolutionize the role of energy storage and information and communication technology (ICT) in the energy sector. With high EV penetration, the battery storage of EVs can be leveraged to improve the efficiency and reliability of electricity delivery via V2G systems. The V2G system enables bidirectional energy delivery, which allows the EV to either draw energy from or feed energy back to the grid. In other words, EVs can facilitate two types of services to the grid, namely, load shaving services and ancillary services to the grid.

Professor El-Saadany (Electrical and Computer Engineering) has developed a new energy management system (EMS) for incorporating aggregated Plug-in Electric Vehicles (PEV) in parking lots. Demand response (DR) capability allows end-use customers to modifying electricity usage based on incentive payments to encourage lower electricity use at times of high prices.

Professor Salama (Electrical and Computer Engineering) has designed a model of charging plug-in hybrid electric vehicles using photovoltaic electricity in residential distribution systems and developed a comprehensive planning model for the electric vehicle charging infrastructure in Ontario.

Professor Bhattacharya’s (Electrical and Computer Engineering) studies include: smart plug-in hybrid (PEV) charging station operation and design, evaluation of distribution system impacts, effect of PEV penetration on distribution system planning and time-of-use electricity prices, smart charging PEVs in an isolated microgrid, and adequacy assessment of power systems with PEV charging loads.

Professors Fraser and Fowler (Faculty of Engineering) have initiated a pilot project on UWaterloo campus along with various faculty members from Management Sciences,

Environment, and Accounting and Finance, to study the impact of high-voltage, direct current (HVDC) charging stations on the distribution grid and battery life of electric vehicles.

Professor Fraser, Professor Fowler, and Professor Young (Faculty of Environment) have worked together on the reuse of electric vehicle lithium ion battery packs in energy storage system applications. Their work concluded that Li-ion battery packs present opportunities for powering both mobility and stationary applications.

Professors Cañizares and Rosenberg's (Electrical and Computer Engineering) award winning paper on 'Day-ahead dispatch of distribution feeders' addresses the issues related to high PEV charging penetration levels.

Professors Cañizares and Kazerani (Electrical and Computer Engineering) have developed the concept of a bidirectional smart charger that give drivers the option of charging when power is plentiful (and rates are cheaper) and earning discounts or rebates by supplying electricity from their vehicles back to the grid when they don't need it.

Professor Kazerani and Cañizares (Electrical and Computer Engineering) have also completed a project on modeling and testing of a bidirectional smart charger for distribution system EV integration. A practical case study demonstrates and tests the proposed smart charger and model, investigating the provision of V2G for active and reactive power in a low voltage (LV) residential distribution network. The results confirm the advantages of the charger model for developing V2G strategies in distribution networks. This project developed a prototype and an average model of a single-phase, two-stage, level one bidirectional smart charger comprising of a full bridge ac/ dc converter and a bidirectional buck-boost converter.

### **EV CHARGING STATIONS**

An important constraint to the deployment of EVs in Canada is the lack of public EV battery charging infrastructure across the country.

In collaboration with WISE and faculty members from Management Sciences, Environment, and Accounting and Finance Professors, Roydon Fraser and Michael Fowler (Faculty of Engineering) have initiated a pilot project on the UW campus to study the impact of high-voltage, direct current (HVDC) charging stations on the local distribution grid and examined data related to the battery life of EVs.

This project has seen UW become the first academic institution in Canada to deploy a HVDC fast charging facility, located in the parking lot of the Engineering 6 (E6) Building. Construction of one level II charger, one level III charger, and one Tesla charger was completed in 2018.

Additionally, Prof. Salama and PhD student Yassir Alhazami have developed a planning model to implement EV charging infrastructure in electric power distribution systems. The results of this study will help to identify ideal locations for charging stations throughout the country and thereby optimize the electricity grid to meet growing EV charging demands. The findings will support the development of sustainable and profitable business models for EV charging infrastructure owners.

## **DRIVE4DATA**

Drive4Data (D4D) is the first initiative of its kind in Canada, providing a trove of data to advance electric vehicle research while supporting local EV owners in the optimum use of their EVs. This initiative was founded in 2012 as a collaboration between WISE and Grand River CarShare, and involves collection of mileage, battery charging and energy use data from hundreds of EV owners in the Waterloo region. The data are relayed to WISE for research purposes, helping to advance a variety of UW faculty-led research initiatives on electric vehicles, from battery technology to smart grid management.

Drive4Data participants have a small wireless device about the size of a cell phone installed in their car, and benefit from access to detailed reports on their vehicle's performance, including the travelled distance, charging schedule, fuel and electricity usage and performance against similar vehicles. Drivers can access detailed reports on their vehicle's performance, including the distance they've travelled, charging schedule, fuel and electricity usage, performance against similar vehicles, and status of battery charge under hot and cold conditions.

The installation of the smart chargers on campus enhances our capacity to allow a larger number of vehicles to be included in the D4D program. Data mining and analytics will support the next generation of modelling tools and algorithms.

Financial support from Waterloo North Hydro, Kitchener-Wilmot Hydro, Cambridge and North Dumfries Hydro, and the Community Environmental Fund administered by the Regional Municipality of Waterloo make this project possible.

## **ELECTRIC BICYCLES**

E-Bikes are becoming the world's fastest growing mode of low-carbon urban transportation. In September 2014, Prof. Keshav initiated the Webike project, deploying a fleet of approximately 30 sensor-equipped electric bicycles to UW faculty, staff, and students.

The Webike project had two main phases. In the first, a survey was disseminated to UW faculty, staff, and students to select suitable participants. The second phase consisted of a three year field test. E-bikes were purchased from eProdigy Bikes, an e-bike manufacturer based in Vancouver, and instrumented with sensors. Participants were then given e-bikes and appropriate training by a local partner, Cycle Electric.

Over 200 GB of anonymized usage data (GPS location, accelerometer readings and battery state) were collected from September 2014 until the culmination of the tests in 2017, and participants were asked to fill out user surveys every three to six months.

Insights from the project have contributed to increased understanding of the potential scope and impact of e-bikes on transportation infrastructure in Canada. The project also evaluated the feasibility of solar powered e-bikes as a cost-effective off-grid transportation solution, and suggested that e-bike batteries could be used as a source of power for high efficiency appliances such as refrigerators and lighting in developing countries.

### 3.1.1.5 GLOBAL ENERGY ACCESS

There are currently 1.2 billion people in the world who still do not have access to electricity. While this number is currently falling, it is estimated that without significant innovation, aggressive investment and invigorated political will, the world will not achieve universal energy access by 2030 — a target now enshrined as UN Sustainable Development Goal 7: Universal Access to Affordable, Reliable, Sustainable and Modern Energy.

In September 2015, WISE launched the Affordable Energy for Humanity (AE4H) initiative in partnership with the Karlsruhe Institute of Technology (KIT) and a global consortium of leading experts in the fields of sustainable energy and international development. This ‘global change initiative’ undertakes research, advocacy and knowledge transfer activities to advance Sustainable Development Goal 7: ensuring access to affordable, reliable, sustainable and modern energy for all by 2030.

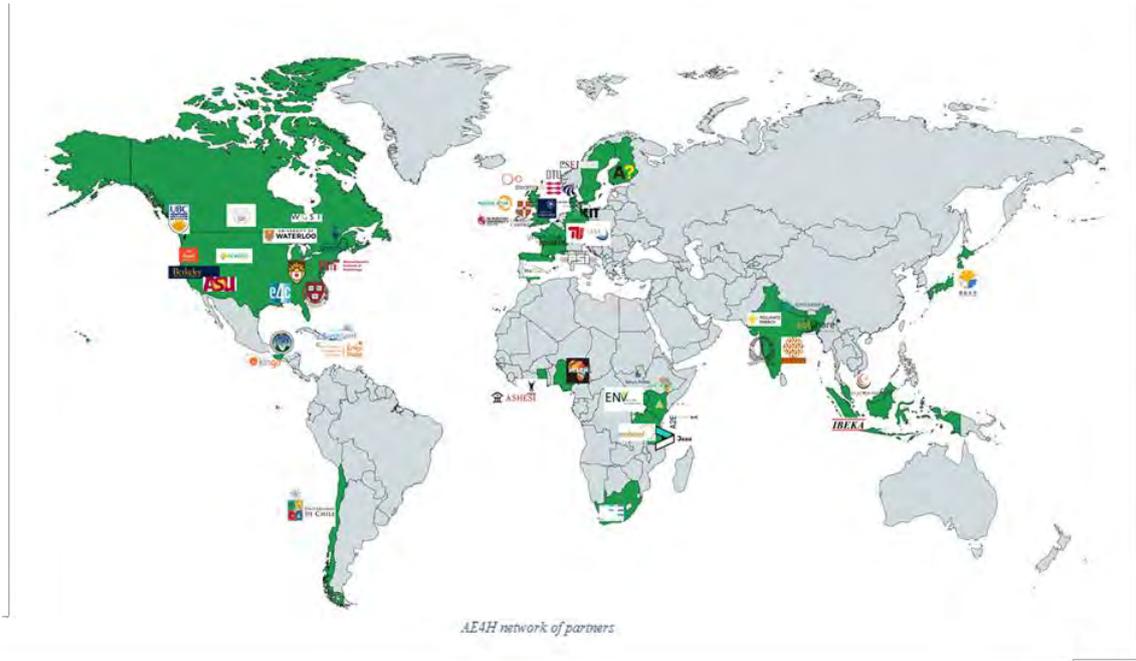


Through founding this new initiative, WISE has made a commitment to advancing the global energy access agenda. At the heart of this commitment is the recognition that access to an affordable supply of clean electricity is a fundamental stepping stone to human development in the 21st century. AE4H puts WISE at the center of a global movement that aims to leverage the potential of cutting edge sustainable energy technologies to improve the quality of life of the third if humanity that lives without reliable access to electricity.

Since it was established in 2015, the AE4H consortium has grown to include over 140 members from 50+ institutions in 25 countries. Scientific Advisors representing the world’s foremost post-secondary research institutions on the topic have also joined the initiative.



*Energy as a sustainable development multiplier*



**AE4H LEADERSHIP**

Co-Directors		Scientific Advisors		
University of Waterloo	Karlsruhe Institute of Technology	University of California, Berkeley	Arizona State University	University of Oxford
				
Jatin Nathwani Executive Director, Waterloo Institute of Sustainable Energy	Joachim Knebel Head of Division II, Electrical and Mechanical Engineering	Dan Kammen Director, Renewable and Appropriate Energy Laboratory	Clark Miller Director, Center for Energy and Society	Malcolm McCulloch Director, Energy and Power Group

**RESEARCH DOMAINS**

Four key domains of research support an interdisciplinary approach to energy access research. AE4H partners are engaged in a number of projects across all four domains. Brief descriptions of members' exemplar projects are included below.

**Domain I: Generation, Devices, and Advanced Materials**

*Exemplar activity: Testing a Novel Hybrid Renewable Energy System*

This project aims to develop a simple, economically viable and robust Hybrid Renewable Energy System (HRES) for off-grid electrical energy supply. The HRES is based on renewable and non-renewable energy sources, in combination with battery storage system, and is being tested in diverse geographical locations including Uganda and Canada.

The project is being carried out by the Competence E (energy) lab at KIT, led by PhD student Mohamed Mamdouh Elkadragy under the supervision of Prof. Nathwani (WISE)

and Knebel (KIT). The system itself will be tested in an off-grid house in Canada owned by an expert in off-grid renewable energy systems, George Colgate, who has collaborated with WISE as a participant in a global summit on energy poverty held in Waterloo. Results of this work are disseminated by WISE through a variety of media, and WISE researchers have co-authored findings with the KIT team.

### ***Domain II: Microgrids for Dispersed Power***

*Exemplar Activity: Partnership with Renewable & Appropriate Energy Laboratory, UC Berkeley*

Directed by Prof. Daniel Kammen, RAEL is a unique research, development and project implementation lab located at the University of California, Berkeley, focussed on the design and implementation of renewable energy systems in regions facing energy poverty. RAEL projects range from small community-driven initiatives in remote locations, to large projects that assess national electrification plans. A number of RAEL researchers have contributed to AE4H initiatives since 2015, including participating in AE4H events, writing joint papers, and collaborating on funding proposals. Prof. Kammen in co-editing an IEEE special issue on 'Electricity of Everyone' with WISE Executive Director Jatin Nathwani and WISE researcher Prof. Claudio Canizares. Prof. Kammen is a Scientific Advisor to AE4H and has contributed to a number of funding proposals that have been submitted by the consortium, including two successful applications for funding to support international 'innovation labs' hosted by AE4H that bring members together to catalyze new projects.

### ***Domain III: ICT for Energy System Convergence***

*Exemplar Activity: Self-serve Pre-Paid Emissions-free Energy Delivery (SPEED)*

Professor Srinivasan Keshav and undergraduate research assistant Kayla Hardie designed a simple and robust standalone device called SPEED, which is a standalone system to charge cell phones and other small electronic devices with solar energy. SPEED enables small businesses to sell emissions-free charging services at an affordable price. The prototype system employs RFID tracking and a user-friendly interface accessible via WI-FI, allowing shopkeepers to easily register new clients, track existing customers, and check the performance of the system.

### ***Domain IV: Environmental and Human Dimensions of Energy Transitions***

*Exemplar Activity: The Social Value of Energy*

WISE has collaborated with ASU's Grassroots Energy Innovation Lab, led by Professor Clark Miller, to develop a framework for understanding the broader social impacts of energy access initiatives. The goal of this work is to contribute to ongoing policy developments at national, international and sub-national levels which aim to use energy access as a lever advance economic and social development. A working paper entitled 'Poverty Eradication through Energy Innovation: A Multi-Layer Framework for Social Value Creation', which was published jointly by both institutions. This working paper has also been submitted to UN in support of the 2019 Global Development Progress Report. Following from this work, ASU and KIT researchers have initiated a field research project that utilizes the framework to assess the impact of ongoing electrification initiatives

across a variety of locations in the Global South. This project is being carried out jointly by AE4H members from ASU, KIT and WISE.

### **ENERGY POVERTY IN REMOTE COMMUNITIES IN CANADA**

Far away from the Canadian electricity grid, about 250 communities, many of whom are mostly indigenous, rely solely on diesel generators to meet their needs for electricity and heat. In many cases, this aging energy infrastructure is woefully insufficient in meeting energy needs. Blackouts are frequent and many communities face 'load restriction' – generators operate at maximum capacity and therefore no additional loads (such as new homes or community facilities) can be connected.

Diesel fuel is enormously expensive in these locations due to transport costs. It also causes local air and noise pollution, and results in recurrent spills which are expensive to clean up and environmentally damaging. According to Indigenous and Northern Affairs Canada, there are over 1,400 sites contaminated by diesel spills on First Nations reserves across Canada.

Between 2015 and 2018 WISE has collaborated with the Waterloo Global Science Initiative and other Canadian partners to host a global summit on the topic of energy poverty in 2016, with an explicit focus on off-grid indigenous communities in Canada. Prof. Nathwani and WISE Manager Nigel Moore, along with UW post-doctoral researcher Marriano Arriaga, developed a position statement following the summit, which was published as a special section of the final summit report. The 'Plan-for-Plenty' position is an urgent call to action targeting government and other actors in Canada to provide a step-change of investment in support of clean, reliable and affordable energy for underserved communities, and the implementation of these projects through indigenous leadership. WISE continues to push this message through engagement with policy-makers, and through partners including the Indigenous Clean Energy Network – a national organization that supports indigenous knowledge sharing on renewable energy.

WISE researchers have also developed and implemented concrete solutions that provide emissions-free energy to off-grid communities in Canada. Professors Claudio Cañizares, Ehab El-Saadany, Paul Parker, Mehrdad Kazerani, Kankar Bhattacharya and David Johnson, in collaboration with NRCan, Hatch, Wenvor, and Hydro One, participated in a project to introduce a renewable micro-grid system in Kasabonika Lake First Nation, an isolated community in northern Ontario only accessible by air or winter roads. The Waterloo team's work focussed on micro-grid controller development, energy management system planning and community engagement. Solar and wind technologies were deployed to augment the use of diesel. WISE researchers worked with the community and industry partners to develop energy plans and models for higher rates of renewable energy penetration on the community's grid.

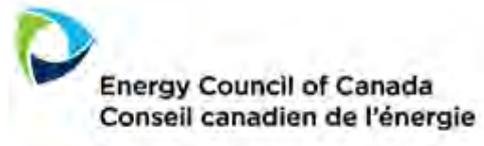
WISE has also partnered with the World Wildlife Foundation (WWF) and Innovus power, to study alternatives to existing diesel systems in the Canadian Arctic. Led by Prof. Claudio Canizares, these studies indicated significant potential for cost savings and GHG emission reductions across a range of communities that currently rely entirely on diesel systems for heat and power. The aim of this work is to develop strategies to optimize the dispatch of carbon-free power at the lowest cost possible in remote locations across Canada.

## 3.1.2 Training and Student Development

### Energy Council of Canada Energy Policy Research Fellowship Program

In 2013, WISE established an agreement with the Energy Council of Canada (ECC) to enhance and promote energy policy research, with a particular focus on thematic areas that align with the priorities of the ECC, and its member organizations across the country.

ECC is a not-for-profit organization made up of representatives of Canada's energy sector. It is a vehicle for strategic thinking, collaboration and action by senior executives in the private and public sectors having a broad interest in national, continental and global energy policy issues.



ECC has provided a total cash contribution of \$500,000 commencing April 1, 2013 continuing to and including September 30, 2023 in support of the ECC Energy Policy Research Fellowship. The program funds University of Waterloo graduate students (both Masters and PhD) to undertake research activities on energy policy-related topics, with a particular focus on contemporary clean energy issues.

This program is managed and administered by Professor Nathwani - Executive Director WISE - with ECC fellows becoming an important source of energy and insight for a variety of other WISE activities. ECC fellows are supported by WISE throughout the duration of their fellowship and until completion of their graduate studies at UW. Examples include participation at WISE events, research assistanceship at WISE including drafting reports and working papers, mentorship, networking assistance, and other activities.

Since the program's inception in 2013, WISE has supported 17 ECC Student Fellows who have received a total of \$319,500 for their research.

The following graduate research projects have been supported by the program to date:

- Development of a utility grade controller for remote microgrids with high penetration renewable generation
- Accelerating progress in renewable energy using a technology-centered co-evolutionary framework
- Examining the potential for smart meter data streams
- Creation of a comprehensive engagement and planning framework for the integration of renewable energy in remote communities
- Technically detailed co-evolutionary model to guide energy innovation policy
- Applying social theories to conservation initiatives
- Wind turbine opposition in Ontario
- Investigate the effectiveness of interventions used in the EHMS project: Residential consumption shifts
- Integrating distributed renewable energy generation into the Canadian electricity distribution system
- Canada's lower carbon energy futures: Multi-level sociotechnical scenarios under the new scenario framework for climate change research
- Engaging residential consumers using smart grid tools

- The socio-technical dimensions of carbon management for bridging to a lower carbon energy future
- Applying social theories to conservation initiatives
- Enabling energy transitions: evaluating the effectiveness of past and present energy transition policies to guide Canada's transition to a low carbon future
- Informing the design, implementation and evaluation of the Decarbonize Waterloo Region process
- Methodology for improving the net environmental impacts of new buildings through product recovery management
- Intra-household dynamics and residential energy conservation policies
- Renewable energy to advance off-grid community sustainability: a comparative energy policy analysis between Alaska and Canada's North
- Carbon management: bridging to a lower carbon energy future

### **Queen Elizabeth Scholars for Energy Access Program**

WISE has been awarded \$300,000 from the Queen Elizabeth II Diamond Jubilee Scholarship Program (funded jointly by the Rideau Hall Foundation, Community Foundations of Canada, and Universities Canada) to prepare UW students for leadership in the emerging off-grid renewable energy sector, with a focus on the developing world.

Between 2018 and 2021, approximately 40 UW students will undertake international internships at sustainable energy social enterprises within the AE4H network.

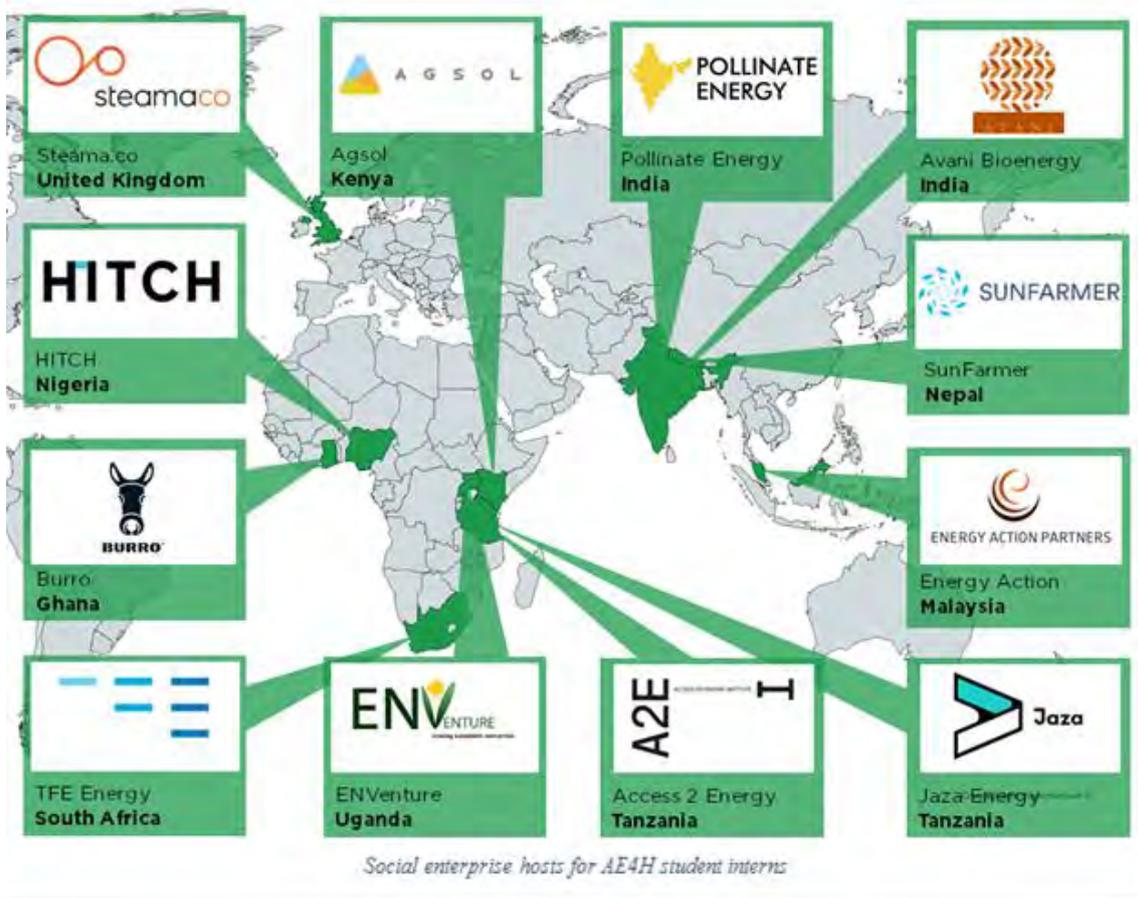
Participation of the AE4H global network of partners and St. Paul's Greenhouse allows opportunities for students to engage with global knowledge networks and develop their own social ventures related to energy access. On campus programming includes social innovation competitions, guest speaker events, and other activities related to this critical and growing development sector that crosses disciplinary boundaries.

Three cohorts of UW students have participated in the program since May 2018, interning at cutting edge social enterprises within the AE4H network, with whom WISE has developed reciprocal relationships.

The program is open to all co-op students and Masters students with a required internship component in their degree. Students from the following programs have participated to date:

- Mechatronics Engineering
- Geological Engineering
- Mechanical Engineering
- Computer Engineering
- Biomedical Engineering
- Civil Engineering
- Environment, Resources and Sustainability
- Planning
- Geography and Environmental Management
- Masters of Development Practice





### Student-Centered Workshop: Rethinking Design for Energy Access

In February 2016 WISE hosted 'Rethinking Design for Energy Access' on the UW campus, inviting students to take part in interactive discussions with experts about the exciting opportunities and challenges facing innovators whose work lays at the boundary between energy and international development. This event was meant to galvanize student interest in universal energy access and the AE4H initiative. It was held in partnership with the Waterloo Global Science Initiative, and two AE4H members were invited to speak to students: Steve Katsaros, Founder & CEO of Nokero Solar, and Iana Aranda, President of Engineering for Change. A unique mix of engineering and international development students participated in the workshop. Videos are available on the AE4H website.



**RETHINKING DESIGN FOR ENERGY ACCESS**

Thursday February 25, 2016 | 3:00 - 6:00 p.m.  
University of Waterloo | DC 1301 (fishbowl lounge)

- Should we design technologies for individual or community ownership?
- Should we design for aid or for trade?
- Is it more important for technologies to be affordable or durable?

Today there are over a billion people without access to electricity for lights or phone chargers, dark operating rooms and schools, and no opportunity to better their livelihoods through the transformative power of reliable electricity.

Are you a student who wants to use your design and engineering skills to make a difference? Help develop the ultra-efficient and ultra-affordable technologies that will improve lives.

Join an interactive discussion with experts about the exciting opportunities available in the emerging field.

The event is part of 'Power Shift' - a series of activities leading up to a major international summit on energy access in Waterloo in April 2016.

**SPEAKERS:**  
Julie Hatheway  
Executive Director, Waterloo Institute for Sustainable Energy  
Steve Katsaros  
Founder and CEO, Nokero Solar  
Iana Aranda  
Director of Programs, Engineering for Change

AE4H | WGS I | WISE

JOIN THE DEBATE on these and other Big Design Questions facing humanitarian innovators by following #Powershiftw

UNIVERSITY OF WATERLOO

The following design questions were considered as part of the discussion:

- Should we promote technologies even if they hurt the environment?
- Should technology for global development always be the cheapest solution?
- Should we make products that are localized or standardized?

- Is technology appropriate if it violates cultural norms?
- Is it more important for technologies to be affordable or durable?
- Should we design for aid or for trade

### **Mentoring UW student teams participating in the Hult Prize Social Innovation Competition**

The Hult Prize is the world's largest student Social Enterprise competition. Teams from all over the world compete annually for a \$1 Million grand prize to put their social enterprise idea into action.

Through the AE4H initiative, WISE actively mentoring a number of Hult Prize teams from the University of Waterloo during their 2017-2018 competition, entitled "Harnessing the Power of Energy to Transform 10 Million Lives".

WISE organized a speed mentoring event for UW teams, with AE4H members Srinivasan Keshav (Waterloo), Malcolm McCulloch (Oxford), Uche Onuora (HITCH), Michael Sinclair (Ecobee) and Nigel Moore (WISE) serving as mentors at the event.

One of our teams, Circadian Energy, placed in the top three in the Waterloo competition and went on to represent the University at a national event in Toronto. Circadian subsequently joined the Velocity incubator program and are refining their energy sharing technology and business plan, which aims to provide off-grid electrification to underserved communities in East Africa. WISE continues to work with the Circadian Energy team as they launch their business.

### **Incubating Off-grid Internet start-up HITCH**

HITCH is a Smart Wireless Mesh Router & Predictive Content Caching Software Platform that pre-downloads relevant online content once, so many users can access the same information quickly without an Internet connection. Globally, over 4 billion people don't have sustainable (available, affordable & accessible) broadband.



HITCH was founded by ICT expert Uche Onuora. After completing his Master of Business, Entrepreneurship and Technology at UW's Conrad Centre, Uche joined Velocity to continue to develop HITCH technology and prepare it for deployment in his native Nigeria. One of the key challenges facing HITCH is lack of consistent access to electricity to run its devices. WISE, through the AE4H initiative, has therefore been supporting HITCH in refining their prototype technology so that it can operate without

electricity for long periods of time, and in conducting initial field tests in Nigeria in 2017-2018. HITCH devices have now been present in 10 schools for a 3-month trial period to intelligently deliver affordable educational video content straight to classrooms. A roll-out to 50 additional schools is now underway.

### **Student Engagement at WISE Events**

WISE encourages student participation at all of our regular events, providing open space for graduate and undergraduate students and young entrepreneurs to present posters during designated poster sessions. These events, which occur 2+ times per year at various WISE events, allow UW students to network with sustainable energy leaders on campus, from the Waterloo Region, and beyond.

## **3.2 Reach Out: Delivering High Value Partnerships**

## ***Reach out:*** **Delivering High Value Partnerships**

WISE is Waterloo's 'front door' for all things sustainable energy – the first stop for those from outside of the University to get to know Waterloo's cutting edge research on this topic.

We work closely with utilities, the private sector, government and non-profit organizations to ground our work in real-world issues. We facilitate partnerships between WISE and our stakeholders that advance along the full spectrum of energy R&D, education and training, networking, and commercialization activities. We advise our UW faculty experts about new partnership and research funding opportunities and provide them with support at every stage to ensure that their proposals have the greatest chance of success.

A central role that WISE plays is in developing relationships with a diverse array of prospective funders and partner organizations. These relationships have resulted in a significant and consistent flow of research dollars into the University, from both traditional sources such as the tri-councils, as well as through multi-year, multi-million dollar partnerships with energy sector companies that help fund our members' research. WISE also helps to secure funding of physical assets such as cutting edge research laboratories and equipment, giving UW faculty experts the tools they need to advance knowledge in their domain.

WISE has successfully built deep long-term reciprocal relationships with industry partners including both small renewable energy start-ups and large established multi-national energy sector players. We have also championed formal research collaborations between UW and a variety of leading Universities at home and abroad, from MIT to Oxford, Berkeley and beyond. We are a valued partner of a number of forward thinking non-profit organizations that we work with to promote responsible and informed public dialogue and policy related to sustainable energy.

WISE's consistent engagement with a multiplicity of leading energy sector players both domestically and internationally help us to understand the bigger picture of where the energy sector is going, and as a result, to communicate these trends to our members. Our members benefit from working with us not only due to increased access to funding, but also from exposure to new ideas and concepts that we help bring into our research community.



**“I have been struck by the constructive ambition of WISE, as it works effectively with many international peers to achieve global impact.”**

Ian H. Rowlands  
PhD Associate Vice-President, International Professor  
School of Environment, Resources and Sustainability

**“WISE has played an important role supporting my research through the coordination of workshops, promotion of research activities at Waterloo, and coordinating initial contact with potential industrial sponsors.”**

Michael Fowler  
Professor  
Chemical Engineering



**“The AE4H Global Change Initiative is an impressive effort that will not only create positive change in the lives of Ontarians but also has the potential to create new enterprises and markets for Ontario and Canadian entrepreneurs.”**

Serge Imbrogno  
Former Deputy Minister of Energy  
Government of Ontario

## 3.2.1 Successful Funding Partnerships

Between 2013 and 2018, WISE has been directly involved in the development of **86 successfully funded projects worth a total of \$23,084,193**. These projects have been developed in partnership with a wide range of funding agencies, industry partners, and academic collaborators, with whom WISE has played a leading role in building relationships on behalf of UW faculty and students.

### 1. A Compressed Air Energy Storage (CAES) Demonstration Project

#### Academic Investigator(s):

- Main PI: Prof. Maurice Dusseault (Earth and Environment Sciences, UW)
- Co-PI: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), and Prof. Giovanni Cascante (Civil and Environmental Eng., UW)

**Industry Partner(s):** NRStor Inc., and Hydrostor Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** Ontario Centres of Excellence (OCE), and Sustainable Technology Development Canada (SDTC)

**Grant Name:** TargetGHG Collaborative Technology Development Program

**Date Approved:** 2017

**Total Project Value:** \$7,200,000

### 2. The Greening Growth Partnership

#### Academic Investigator(s):

- Main PI: Stewart Elgie (Smart Prosperity Institute)
- UW Collaborators: Prof. Jatin Nathwani (Management Sciences), Nigel Moore (WISE Manager)

**Industry Partner(s) and Other Organization(s):** Environment and Climate Change Canada; Natural Resources Canada; Statistics Canada; Innovation, Science and Economic Development Canada; Agriculture and Agri-Food Canada; Ministry of Environment and Climate Change, Ontario; Développement durable, Environnement et Lutte contre les changements climatiques, Québec; Ministry of Economic Development and Trade, Alberta; Ministry of Sustainable Development, Manitoba; Global Green Growth Knowledge Platform; Resources For The Future (RFF); Ecologic Institute; International Institute for Sustainable Development (IISD); The Pembina Institute; Insitute economique de Quebec; The Centre for the Study of Living Standards; The Centre for Indigenous Environmental Resources; Pacific Institute for Climate Solutions; Broadbent Institute; Canadians for Clean Prosperity; Canadian Climate Forum; The Natural Step; Canadian Urban Institute; Mars Discovery District; Alberta Innovates Technology Futures; InnoTech; Cleantech Group; Canadian Agri-Food Policy Institute; Ducks Unlimited; Nature Conservancy of Canada; Alberta Land Institute; The Ivey Foundation; Sitka Foundation; Forest Products Association of Canada; Cement Association of Canada; Aluminum Association of Canada; McKinsey & Co.; Analytica Advisors; Stratos Inc.; Earnscliffe; The Co-Operators; Royal Bank of Canada (RBC); Desjardins; InvestEco; Shell Canada Inc.; NRStor; Bioamber; Tembec; Seimens; Unilever Canada; I2 Ideas and Issues Advertising; Abacus Data; The Conversation, Venture Communications, Corporate Knights

**Other Academic Institution(s):** The University of Toronto, University College London, The London School of Economics

**Funding Agencies:** The Social Sciences and Humanities Research Council of Canada

**Grant Name:** SSHRC Partnership Grant

**Date Approved:** 2017

**Total Project Value:** \$2,500,000

### 3. Resilient and Sustainable Energy for Northern Canada

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)
- Co-PIs: Prof. Yuri Leonenko (Earth and Environmental Sciences, UW), Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), and Prof. Robert Gracie (Civil and Environmental Eng., UW)

**Industry Partner(s) and Other Organization(s):** Geosource Energy Inc., Egmond Associates Ltd., and Natural Resources Canada (NRCan)

**Other Academic Institution(s):** University of Manitoba, and Institut national de la recherche scientifique (INRS)

**Funding Agencies:** Defence Research and Development Canada (DRDC)

**Grant Name:** Innovation Call For Proposals (CFP) 2017

**Date Approved:** 2017

**Total Project Value:** \$1,848,209

### 4. Hydro One Endowed Chair, Claudio Canizares

**Academic Investigator(s):**

- Main PI: Prof. Claudio Canizares (Electrical and Computer Eng., UW)
- Co-PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2010

**Total Project Value:** \$1,500,000

### 5. Compressed Air Energy Storage in Salt Caverns in Canada

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Civil and Environmental Eng., UW)
- Co-PIs: Prof. Claudio Canizares (Electrical and Computer Eng., UW), Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), Prof. Jatin Nathwani (Management Sciences, UW), Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW), Prof. Dipanjan Basu (Civil and Environmental Eng., UW), Prof. Andy Knight,

Electrical and Computer Eng., UC), Prof. Hamid Zareipour (Electrical and Computer Eng., UA), and Prof. Nicholas Harris (Earth and Atmospheric Sciences, UA).

**Industry Partner(s):** Hydro One, Ontario Power Generation, Union Gas, NRStor, Compass Minerals, and Rocky Mountain Power

**Other Academic Institution(s):** University of Calgary and University of Alberta

**Funding Agencies:** NSERC, OCE, and Alberta Innovates

**Grant Name:** Alberta-Ontario Innovation Program/NSERC Collaborative Research and Development (CRD)

**Date Approved:** 2015

**Total Project Value:** \$1,370,417

## 6. Management and Control of Energy Use in Homes and Buildings

**Academic Investigator(s):**

- Main PI: Prof. Srinivasan Keshav (Cheriton School of Computer Science., UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Collaborative Research and Development (CRD) Grant

**Date Approved:** 2013

**Total Project Value:** \$1,330,675

## 7. Optimal Microstructures and Thermomechanical Properties of Ceramic Heat Carrier Balls for Waste to Energy Conversion

**Academic Investigator(s):**

- Main PI: Prof. John Wen (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** Lockheed Martin Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC, Innotech Alberta, and OCE

**Grant Name:** NSERC Collaborative and Research Development (CRD)

**Date Approved:** 2016

**Total Project Value:** \$1,035,284

## 8. CISCO Research Chair in Smart Grid, Srinivasan Keshav

**Academic Investigator(s):**

- Main PI: Prof. Srinivasan Keshav (Cheriton School of Computer Science., UW)
- Co-PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** CISCO Research Chair in Smart Grid

**Date Approved:** 2013

**Total Project Value:** \$1,000,000

### 9. Internships at Energy Access Social Enterprises for University of Waterloo Students

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)
- Co-PI: Nigel Moore, WISE Manager
- UW Collaborators: Tania Del Matto, St.Paul's Greenhouse; Grainne Ryder, SEED; Lisa ter Woort, CECA

**Industry Partner(s):** Mobisol, Nokero Solar, ME SolShare, HITCH, EarthSpark International, Burro Brand, Steama.co, ENVenture

**Other Academic Institution(s):** N/A

**Funding Agencies:** The Rideau Hall Foundation, Universities Canada, Community Foundations of Canada

**Grant Name:** Queen Elizabeth II Diamond Jubilee Scholarship Program - 2017

**Date Approved:** 2018

**Total Project Value:** \$824,350

### 10. Advanced Information and Communication System for Smart Grid

**Academic Investigator(s):**

- Main PI: Prof. Xuemin Shen (Electrical and Computer Eng., UW)
- Co-PI: Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW), Prof. Jon Mark (Electrical and Computer Eng., UW)

**Industry Partner(s):** Waterloo North Hydro (WNH)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** Strategic Projects - Group

**Date Approved:** 2016

**Total Project Value:** \$530,100

### 11. Operation, Communication and Information Management for Smart Electricity Grids

**Academic Investigator(s):**

- Main PI: Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One, ABB Corporate Research, and IBM Canada Ltd

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One, and NSERC

**Grant Name:** WISE-Hydro One MOU, and NSERC Strategic Projects - Group

**Date Approved:** 2013

**Total Project Value: \$516,596**

## 12. Impact of Electric Vehicles on the Grid

### Academic Investigator(s):

- Main PI: Prof. Catherine Rosenberg (Electrical and Computer Eng., UW)

**Industry Partner(s) and Other Organization(s):** Hydro One, IBM Canada Ltd, and Ministry of Economic Development and Trade

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Collaborative Research and Development (CRD)

**Date Approved:** 2014

**Total Project Value: \$360,000**

## 13. Memorandum of Understanding – Changfeng Energy

### Academic Investigator(s):

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** Changfeng Energy

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Grant Name:** N/A

**Date Approved:** 2017

**Total Project Value: \$300,000**

## 14. Using Smart Grid Technologies to Reduce Production Costs and Increase Access to Renewable Energy in Power Systems

### Academic Investigator(s):

- Main PI: Prof. Claudio Canizares (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One, NSERC

**Grant Name:** WISE-Hydro One MOU, and NSERC Collaborative and Research Development (CRD) Grant

**Date Approved:** 2013

**Total Project Value: \$224,500**

## 15. Active Distribution Systems: Modeling, Planning and Control Design

### Academic Investigator(s):

- Main PI: Prof. Magdy Salama (Electrical and Computer Eng., UW)

**Industry Partner(s) and Other Organization(s):** Hydro One, and Natural Resources Canada (NRCan)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Collaborative Research and Development (CRD)

**Date Approved:** 2014

**Total Project Value:** \$210,000

## 16. Probabilistic Planning and Billing Management

### Academic Investigator(s):

- Main PI: Prof. Catherine Rosenberg (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$180,000

## 17. Increasing renewable generation connectivity in the transmission system of Ontario through use of innovative DG controls

### Academic Investigator(s):

- Main PI: Prof. Magdy Salama (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$150,000

## 18. Dynamic Interactions in Active Distribution Systems: Modeling, Analysis and Suppression via Control Design

### Academic Investigator(s):

- Main PI: Prof. Magdy Salama (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One  
**Grant Name:** WISE-Hydro One MOU  
**Date Approved:** 2013

**Total Project Value:** \$150,000

## 19. EV Charging Infrastructure on UW Campus

### Academic Investigator(s):

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)
- Co-PI: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), Prof. Nasser Azad (Systems Design Eng., UW), Prof. Michael Fowler (Chemical Eng., UW), Prof. Weihua Huang (Electrical and Computer Eng., UW), Prof. Sheshakamal Jayaram (Electrical and Computer Eng., UW), Prof. Mehrdad Kazerani (Electrical and Computer Eng., UW), Prof. Amir Khajepour (Mechanical and Mechatronics Eng., UW), Prof. Kumaraswamy Ponnambalam (Systems Design Eng., UW), Prof. Armaghan Salehian (Mechanical and Mechatronics Eng., UW), Prof. Sherman Shen (Electrical and Computer Eng., UW), Prof. Lan Wei (Electrical and Computer Eng., UW), Prof. Ramandan El Shatshat (Electrical and Computer Eng., UW), Prof. John McPhee (Systems Design Eng., UW), Prof. Steven Young (School of Environment, Enterprise and Development), Prof. Paul Parker (School of Environment, Enterprise and Development), and Prof. Ranjini Jha (School of Accounting and Finance)

**Industry Partner(s):** N/A

**Equipment Supplier(s):** AddEnergie, Tesla, and Fluke

**Other Academic Institution(s):** N/A

**Funding Agencies:** University of Waterloo

**Grant Name:** N/A

**Date Approved:** 2016

**Total Project Value:** \$105,000

## 20. Non-destructive Condition Assessment of Wood Poles using Ultrasonic Waves

### Academic Investigator(s):

- Main PI: Prof. Giovanni Cascante (Civil & Environmental Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$100,000

## 21. Analysis and Optimization of a Permanent Magnet Harvesting Device

### Academic Investigator(s):

- Main PI: Behrad Khamesee (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** Mag-Tech Renewable Energies Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Collaborative Research and Development (CRD)

**Date Approved:** 2017

**Total Project Value:** \$83,500

## 22. The Energy Hub Management II: Empowering LDCs to Enable the Smart Grid

### Academic Investigator(s):

- Main PI: Prof. Claudio Canizares (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$75,000

## 23. Colas Agreements – Contract: ISO 9001, Contract: OHSAS 18001, Contract: Quality Management and Control Webinars

### Academic Investigator(s):

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** Colas Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Grant Name:** N/A

**Date Approved:** 2017

**Total Project Value:** \$68,000

## 24. Highly Efficient, Self-Powered Traffic Event Detection System

### Academic Investigator(s):

Main PI: Prof. Kumaraswamy Ponnambalam (Systems Design Engineering, UW)

**Industry Partner(s):** Miovision

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC and OCE

**Grant Name:** NSERC Engage + OCE VIP 1  
**Date Approved:** 2016

**Total Project Value:** \$65,000

## **25. Accelerating Energy Access Solutions: Field-Based Knowledge, Fundamental Research, and the Role of Incubation Platforms**

### **Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)
- Co-PI: Nigel Moore, WISE Manager
- UW Collaborators: Neil Craik, Ian Rowlands, Srinivasan Keshav; Claudio Canizares, Bissan Ghaddar, Mehrdad Kazerani

**Industry Partner(s) or Other Organizations:** The Waterloo Global Science Initiative  
**Other Academic Institution(s):** The Karlsruhe Institute of Technology, The University of Oxford, The University of California, Berkeley, Carnegie Mellon University, Ashesi University, Aalto University, The University of Southampton, Penn State University, The Institute for advanced sustainability Studies

**Funding Agencies:** University of Waterloo + Matching funds from academic partners (KIT & WGSU)

**Grant Name:** International Research Partnership Grant

**Date Approved:** 2016

**Total Project Value:** \$60,000

## **26. R&D of Control Platform for Integration of Renewable Energy in Remote Communities**

### **Academic Investigator(s):**

- Main PI: Prof. Claudio Canizares (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$60,000

## **27. Smart Grid Load Balancing & Energy Storage by Power-to-Gas via Methanation in Ontario and Germany**

### **Academic Investigator(s):**

- Main PI: Prof. David Simakov (Chemical Eng., UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund  
**Date Approved:** 2013  
**Total Project Value:** \$52,000

## 28. Distributed Generation Multi-Agent Voltage and Reactive Power Control

**Academic Investigator(s):**

- Main PI: Prof. Ehab El-Saadany (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One  
**Other Academic Institution(s):** N/A  
**Funding Agencies:** Hydro One  
**Grant Name:** WISE-Hydro One MOU  
**Date Approved:** 2013

**Total Project Value:** \$50,000

## 29. Developing a Stabilizing Control for Microgrid Systems

**Academic Investigator(s):**

- Main PI: Prof. Ehab El-Saadany (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One  
**Other Academic Institution(s):** N/A  
**Funding Agencies:** Hydro One  
**Grant Name:** WISE-Hydro One MOU  
**Date Approved:** 2013

**Total Project Value:** \$50,000

## 30. Affordable Energy for Humanity Innovation Lab

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)
- Co-PI: Nigel Moore, WISE Manager
- UW Collaborators: Srinivasan Keshav; Claudio Canizares, Bissan Ghaddar, Mehrdad Kazerani

**Industry Partner(s):** N/A  
**Other Academic Institution(s):** The Karlsruhe Institute of Technology, The University of Oxford, The Massachusetts Institute of Technology, University of California, Berkeley, Arizona State University  
**Funding Agencies:** University of Waterloo + Matching funds from Academic partner (KIT)  
**Grant Name:** International Research Partnership Grant  
**Date Approved:** 2018

**Total Project Value:** \$47,000

### 31. Energy Harvesting for Sensors in Smart Grids

**Academic Investigator(s):**

- Main PI: Prof. Armaghan Salehian (Mechanical and Mechatronics Eng., UW)
- Co-PIs: Prof. Lan Wei (Electrical and Computer Eng., UW), and Prof. David Nairn (Electrical and Computer Eng., UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** University of Bordeaux (France), and Delft University of Technology (Netherlands)

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund

**Date Approved:** 2013

**Total Project Value:** \$46,000

### 32. Non-Destructive Testing of Utility Wood Poles

**Academic Investigator(s):**

- Main PI: Prof. Mahesh Pandey (Civil and Environmental Eng., UW)

**Industry Partner(s):** Waterloo North Hydro (WNH)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage

**Date Approved:** 2016

**Total Project Value:** \$43,600

### 33. Intermediate Grade Geothermal Energy

**Academic Investigator(s):**

- Main PI: Prof. Dipanjan Basu (Civil and Environmental Eng., UW)

**Industry Partner(s):** Borealis Geopower

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage

**Date Approved:** 2015

**Total Project Value:** \$42,100

### 34. Integration and Impact Assessment of AC/DC Hybrid Distribution Grids

**Academic Investigator(s):**

- Main PI: Prof. Kumaraswamy Ponnambalam (Systems Design Eng., UW)

**Industry Partner(s):** Newmarket-Tay Power Distribution Ltd (NTPDL)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC  
**Grant Name:** NSERC Engage Grant  
**Date Approved:** 2017

**Total Project Value:** \$39,700

### 35. Ground Source Heat Pump (GSHP) Systems in Ontario

**Academic Investigator(s):**

- Main PI: Prof. Dipanjan Basu (Civil and Environmental Eng., UW)

**Industry Partner(s):** GeoSmart Energy Inc.  
**Other Academic Institution(s):** N/A  
**Funding Agencies:** NSERC  
**Grant Name:** NSERC Engage  
**Date Approved:** 2016

**Total Project Value:** \$39,300

### 36. Smart Meter Data Mining

**Academic Investigator(s):**

- Main PI: Prof. Lukasz Golab (Management Sciences, UW)

**Industry Partner(s):** CISCO Canada Inc.  
**Other Academic Institution(s):** N/A  
**Funding Agencies:** CISCO Canada Inc.  
**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund  
**Date Approved:** 2013

**Total Project Value:** \$39,000

### 37. Stochastic Modeling and Optimization for PEV Charging Station Operation in Smart Distribution Systems

**Academic Investigator(s):**

- Main PI: Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW)

**Industry Partner(s):** CISCO Canada Inc.  
**Other Academic Institution(s):** N/A  
**Funding Agencies:** CISCO Canada Inc.  
**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund  
**Date Approved:** 2013

**Total Project Value:** \$39,000

### 38. Technical Feasibility of Helical Piles to Extract Shallow Geothermal Energy

**Academic Investigator(s):**

- Main PI: Prof. Dipanjan Basu (Civil and Environmental Eng., UW)

**Industry Partner(s):** Almita Piling Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Date Approved:** 2017

**Total Project Value:** \$39,000

### 39. Developing an Energy Harvesting Generator with Permanent Magnets

**Academic Investigator(s):**

- Main PI: Prof. Behrad Khamesee (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** Mag-tech Renewable Energies Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage

**Date Approved:** 2016

**Total Project Value:** \$37,500

### 40. Advancing Geothermal Drilling Techniques in Canada

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)

**Industry Partner(s):** Scientific Drilling International Inc. (Canada)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Date Approved:** 2017

**Total Project Value:** \$36,000

### 41. Voltage Waveforms Effects on Power System Insulation Under High Frequency and Fast Transients

**Academic Investigator(s):**

- Main PI: Prof. Sheshakamal Jayaram (Electrical and Computer Eng., UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$36,000

#### 42. Permafrost Thermosyphon

**Academic Investigator(s):**

- Main PI: Prof. Yuri Leonenko (Earth and Environmental Sciences, UW)

**Industry Partner(s):** Sigma Energy Storage

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Date Approved:** 2018

**Total Project Value:** \$36,000

#### 43. Developing Intermediate Grade Geothermal Energy for Canada

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)

**Industry Partner(s):** Deep Earth Energy Production

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Date Approved:** 2016

**Total Project Value:** \$35,000

#### 44. Technical and Life Cycle Cost Assessment of Zero-Emission Transport Refrigeration Units

**Academic Investigator(s):**

- Main PI: Prof. Sanjeev Bedi (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** VoltaAir Technology Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Date Approved:** 2017

**Total Project Value:** \$35,000

#### 45. HITCH - Smart Mesh Routers for Community Broadband & Off-Grid Renewable Energy Access in Remote Areas

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani, (Management Sciences)
- Main PI: Prof. Mahesh Pandey (Civil and Environmental Eng., UW)

**Industry Partner(s):** CISCO Canada Inc., HITCH (by flexfinity)

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund

**Date Approved:** 2013

**Total Project Value:** \$28,072

#### 46. A Novel Self-Contained Piezo-Magnetic Sensor for Failure Detection in Power Grids

**Academic Investigator(s):**

- Main PI: Prof. Armaghan Salehian (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund

**Date Approved:** 2013

**Total Project Value:** \$26,000

#### 47. Efficient Analysis of Smart Meter Energy Data

**Academic Investigator(s):**

- Main PI: Prof. Wojciech Golab (Electrical and Computer Eng., UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund

**Date Approved:** 2013

**Total Project Value:** \$26,000

#### 48. Accelerating Progress in Renewable Energy Using a Technology-Centered Co-Evolutionary Framework

**Student Researcher:**

- Yonatan Strauch (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Stephen Quilley (School of Environment, Resources and Sustainability, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2014

**Total Project Value:** \$25,000

#### **49. Development of a utility grade controller for remote microgrids with high penetration renewable generation**

**Student Researcher:**

- Konstantinos Karanasios (Geography and Environmental Management, Faculty of Environment)

**Supervisor:**

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2014

**Total Project Value:** \$25,000

#### **50. Integrating Distributed Renewable Energy Generation into the Canadian Electricity Distribution System**

**Student Researcher:**

- Dane Labonte (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Ian Rowlands (School of Environment, Resources and Sustainability, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2016

**Total Project Value:** \$23,000

### 51. Optimization and Machine Learning for Smart Grid Applications

**Academic Investigator(s):**

- Main PI: Prof. Bissan Ghaddar (Management Sciences, UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund

**Date Approved:** 2013

**Total Project Value:** \$19,500

### 52. Investigate the Effectiveness of Interventions Used in the EHMS Project: Residential Consumption Shifts

**Student Researcher:**

- Bronwyn Lazowski (Department of Geography & Environmental Management (GEM))

**Supervisor:**

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master to PhD Fellowship

**Date Approved:** 2016

**Total Project Value:** \$19,000

### 53. Annual Technology Innovation and Policy Forum 2017 – Disruptive Innovation Over the Wires: Business Models for Success

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Connect Level II Grant

**Date Approved:** 2017

**Total Project Value:** \$16,750

#### 54. Frequency Control Strategies for Future Microgrids

**Academic Investigator(s):**

- Main PI: Prof. John Simpson-Porco (Electrical and Computer Eng., UW)

**Industry Partner(s):** CISCO Canada Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** CISCO Canada Inc.

**Grant Name:** WISE-CISCO Systems Smart Grid Research Fund

**Date Approved:** 2013

**Total Project Value:** \$16,250

#### 55. Canada's Lower Carbon Energy Futures: Multi-level Sociotechnical Scenarios under the New Scenario Framework for Climate Change Research

**Student Researcher:**

- Herijadi Kurniawan (Department of Geography and Environmental Management)

**Supervisor:**

- Prof. Vanessa Schweizer (Knowledge Integration) and Prof. Johanna Wandel (Geography and Environmental Management)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master Fellowship

**Date Approved:** 2016

**Total Project Value:** \$16,000

#### 56. Wind Turbine Opposition in Ontario

**Student Researcher:**

- Tanya Christidis (School of Planning, Faculty of Environment)

**Supervisor:**

- Dr. Geoff Lewis (School of Planning, Faculty of Environment) and Dr. Phil Bigelow (School of Public Health and Health Systems, Faculty of Applied Health Sciences)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2015

**Total Project Value:** \$15,000

### **57. Creation of a Comprehensive Engagement and Planning Framework for the Integration of Renewable Energy in Remote Communities**

**Student Researcher:**

- Konstantinos Karanasios (Geography and Environmental Management, Faculty of Environment)

**Supervisor:**

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2015

**Total Project Value:** \$15,000

### **58. Methodology for Improving the Net Environmental Impacts of New Buildings through Product Recovery Management**

**Student Researcher:**

- Benjamin Sanchez Andrade (Civil and Environmental Engineering, Faculty of Engineering)

**Supervisor:**

- Prof. Carl Haas (Civil and Environmental Engineering, Faculty of Engineering)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2017

**Total Project Value:** \$15,000

### **59. Intra-Household Dynamics and Residential Energy Conservation Policies**

**Student Researcher:**

- Ines Havet (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Ian Rowlands (School of Environment, Resources and Sustainability, Faculty of Environment) and Prof. Andrea Collins (School of Environment, Resources and Sustainability, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$15,000

### **60. Renewable Energy to Advance Off-Grid Community Sustainability: A Comparative Energy Policy Analysis between Alaska and Canada's North**

**Student Researcher:**

- Nicholas Mercer (Department of Geography and Environmental Management)

**Supervisor:**

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$15,000

### **61. Applying Social Theories to Conservation Initiatives**

**Student Researcher:**

- Stephanie Whitney (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Jennifer Lynes (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2015

**Total Project Value:** \$13,000

## 62. Examining the Potential for Smart Meter Data Streams

**Student Researcher:**

- Gordon Stephen (School of Environment, Enterprise and Development, Faculty of Environment)

**Supervisor:**

- Prof. Ian Rowlands (School of Environment, Resources and Sustainability, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master Fellowship

**Date Approved:** 2015

**Total Project Value:** \$10,000

## 63. Thinking Outside the Box: What can energy entrepreneurs in the global south teach Canadian communities about imagining and implementing low carbon energy solutions?

**Student Researcher:**

- Scott Morton Ninomiya (School of Environment, Enterprise and Development, Faculty of Environment)

**Supervisor:**

- Prof. Sarah Burch (Geography and Environmental Management)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$10,000

## 64. Distributed Energy Resources (DERs): Shaping the Pathways and Policies for a Low-Carbon Energy System

**Student Researcher:**

- Hsiu-Chuan Chang (Management Sciences, Faculty of Engineering)

**Supervisor:**

- Prof. Bissan Ghaddar (Management Sciences, Faculty of Engineering)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A  
**Funding Agencies:** N/A  
**Award Type:** Masters Fellowship  
**Date Approved:** 2018

**Total Project Value:** \$10,000

## 65. Increasing Societal Awareness About the Impacts of Anthropogenic Climate Change

### Student Researcher:

- Nicholas Palaschuk (School of Environment, Enterprise and Development, Faculty of Environment)

### Supervisor:

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$10,000

## 66. Participation of Energy Storage in Electricity Markets and Retail Flexibility Provisions toward a Low Carbon Economy

### Student Researcher:

- Nitin Padmanabhan (Electrical and Computer Engineering, Faculty of Engineering)

### Supervisor:

- Prof. Kankar Bhattacharya (Electrical and Computer Engineering, Faculty of Engineering)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$10,000

## 67. Mitigating the Systemic Consequences of Stranded Carbon Assets Along the Path of Decarbonization

**Student Researcher:**

- Truzaar Dordi (School of Environment, Resources and Sustainability)

**Supervisor:**

- Prof. Olaf Weber (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$10,000

## 68. Peer-to-Peer Communication for Distributed Energy Generation and Storage

**Academic Investigator(s):**

- Main PI: Prof. Srinivasan Keshav (Cheriton School of Computer Science, UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU

**Date Approved:** 2013

**Total Project Value:** \$7,500

## 69. The Socio-Technical Dimensions of Carbon Management for Bridging to a Lower Carbon Energy Future

**Student Researcher:**

- Herijadi Kurniawan (Department of Geography and Environmental Management)

**Supervisor:**

- Prof. Vanessa Schweizer (Knowledge Integration) and Prof. Johanna Wandel (Geography and Environmental Management)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master Fellowship

**Date Approved:** 2017

**Total Project Value:** \$7,500

## 70. Carbon Management: Bridging to a Lower Carbon Energy Future

### Student Researcher:

- Benjamin Sanchez Andrade (Civil and Environmental Engineering, Faculty of Engineering)

### Supervisor:

- Prof. Carl Haas (Civil and Environmental Engineering, Faculty of Engineering)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$7,500

## 71. Enabling Energy Transitions – Evaluating the effectiveness of past and present energy transition policies to guide Canada’s transition to a lower carbon energy future

### Student Researcher:

- Christopher Beninger (School of Environment, Enterprise and Development, Faculty of Environment)

### Supervisor:

- Prof. Olaf Weber (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master Fellowship

**Date Approved:** 2017

**Total Project Value:** \$7,500

## 72. Energy Education in the North: Literature review, design features and unit plans

### Academic Investigator(s):

- Main PI: Prof. Paul Parker (School of Environment, Enterprise and Development, UW)

**Industry Partner(s):** Hydro One

**Other Academic Institution(s):** N/A

**Funding Agencies:** Hydro One

**Grant Name:** WISE-Hydro One MOU  
**Date Approved:** 2013

**Total Project Value:** \$7,000

### 73. Technically Detailed Co-Evolutionary Model to Guide Energy Innovation Policy

**Student Researcher:**

- Yonatan Strauch (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Stephen Quilley (School of Environment, Resources and Sustainability, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2015

**Total Project Value:** \$7,000

### 74. Innovation in Building Science - Transition to Low Carbon Energy Buildings

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Connect Level II Grant

**Date Approved:** 2018

**Total Project Value:** \$6,470

### 75. Geothermal Symposium

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Connect Level II Grant

**Date Approved:** 2017

**Total Project Value:** \$6,099

## 76. Resource Recovery Partnership Workshop 2017

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Connect Level II Grant

**Date Approved:** 2017

**Total Project Value:** \$5,646

## 77. WISE Energy Day 2018

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Connect Level II Grant

**Date Approved:** 2018

**Total Project Value:** \$5,225

## 78. Engaging Residential Consumers Using Smart Grid Tools

**Student Researcher:**

- Bronwyn Lazowski (Department of Geography & Environmental Management (GEM))

**Supervisor:**

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master to PhD Fellowship

**Date Approved:** 2017

**Total Project Value:** \$5,000

### 79. Wind Turbine Opposition in Ontario (Renewal)

**Student Researcher:**

- Tanya Christidis (School of Planning, Faculty of Environment)

**Supervisor:**

- Prof. Geoff Lewis (School of Planning, Faculty of Environment) and Prof. Phil Bigelow (School of Public Health and Health Systems, Faculty of Applied Health Sciences)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2016

**Total Project Value:** \$5,000

### 80. Integrating Distributed Renewable Energy Generation into the Canadian Electricity Distribution System (Renewal)

**Student Researcher:**

- Dane Labonte (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Ian Rowlands (School of Environment, Resources and Sustainability, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2017

**Total Project Value:** \$5,000

### 81. Applying Social Theories to Conservation Initiatives (Renewal)

**Student Researcher:**

- Stephanie Whitney (School of Environment, Resources and Sustainability, Faculty of Environment)

**Supervisor:**

- Prof. Jennifer Lynes (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship  
**Date Approved:** 2017

**Total Project Value:** \$5,000

### **82. To inform the design, implementation and evaluation of the Decarbonize Waterloo Region process (Decarbonize WR)**

**Student Researcher:**

- Scott Morton Ninomiya (School of Environment, Enterprise and Development, Faculty of Environment)

**Supervisor:**

- Prof. Sarah Burch (Geography and Environmental Management)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** Master Fellowship

**Date Approved:** 2017

**Total Project Value:** \$5,000

### **83. Product Recovery Management Based Methodology for Improving the Net Environmental Impacts of Capital Project Delivery for Buildings**

**Student Researcher:**

- Benjamin Sanchez Andrade (Civil and Environmental Engineering, Faculty of Engineering)

**Supervisor:**

- Prof. Carl Haas (Civil and Environmental Engineering, Faculty of Engineering)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$5,000

### **84. Renewable Energy to Advance Off-Grid Community Sustainability: A Comparative Energy Policy Analysis between Alaska and Canada's North**

**Student Researcher:**

- Nicholas Mercer (Department of Geography and Environmental Management)

**Supervisor:**

- Prof. Paul Parker (School of Environment, Enterprise and Development, Faculty of Environment)

**Funding Partner(s):** Energy Council of Canada (ECC)

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Award Type:** PhD Fellowship

**Date Approved:** 2018

**Total Project Value:** \$5,000

**85. Annual Technology Innovation and Policy Forum 2016 – Microgrids and Distributed Energy: Is there a revolution in the making?**

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Connect Level II

**Date Approved:** 2016

**Total Project Value:** \$3,350

**86. WISE Energy Day 2017**

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** Ontario Centres of Excellence (OCE)

**Grant Name:** N/A

**Date Approved:** 2017

**Total Project Value:** \$1,000

## 3.2.2 Funding Proposals in Development

WISE has developed many funding proposals on behalf of our members that have yet to receive funding. A number of these are in the process of resubmission.

### 1. Driving a Revolution in 'Affordable Energy for Humanity'

#### Abstract:

Energy Access is recognized as a powerful multiplier of the United Nations Sustainable Development Goals (SDGs) with direct links to provision of adequate healthcare, education and food, as well as gender equality and economic empowerment. Providing energy access to the over one billion people on the planet who are currently living without it must be accomplished through the diffusion of clean technology, or else global climate change targets will be imperilled. The dual challenges of development and sustainability make clean energy access for those at the base of the economic pyramid the quintessential sustainable development challenge of the 21st century.

We believe that eradication of energy poverty with clean technology by 2030 (Sustainable Development Goal 7) will require breakthrough solutions that are designed for implementation in a diverse range of local contexts and delivered by a generation of local change-agents and entrepreneurs. If we are to take maximum advantage of the capacity for innovation that exists within university research labs, there is a need to build stronger bridges between local implementers and global knowledge networks. The proposed program operationalizes such an approach, on a global scale.

The proposed program would establish five Energy Access Innovation Centres (EAICs)—one in Latin America, one in Asia, and three in Africa (South, East & West Africa). EAIC funding will support the establishment of a global fellowship program and its project/enterprise support infrastructure, the extension service, global summits, and a fund for research and implementation activities managed by the EAICs on a competitive and needs basis. The latter fund will be used to accelerate upstream research and downstream deployment of locally appropriate solutions that directly serve the five EAIC regions and accounts for approximately one third of total program budget.

#### Academic Investigator(s):

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)
- Co-PI: Prof. Srinivasan Keshav (Cheriton School of Computer Science, UW), Prof. Claudio Canizares (Electrical and Computer Eng., UW), Prof. Mehrdad Kazerani (Electrical and Computer Eng., UW), Prof. Catherine Rosenberg (Electrical and Computer Eng., UW), Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW), Prof. Ehab El-Saadany (Electrical and Computer Eng., UW), Prof. Magdy Salama (Electrical and Computer Eng., UW), Prof. Siva Sivorththaman (Electrical and Computer Eng., UW), Prof. Keith Hipel (Systems Design Eng., UW), Prof. Yuning Li (Chemical Eng., UW), Prof. Hany Aziz (Electrical and Computer Eng., UW), Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), Prof. Linda Nazar (Chemistry), Prof. Maurice Dusseault (Earth and Environmental Sciences, UW), Prof. Neil Craik (School of Environment, Enterprise and Development), Prof. Paul Parker (School of Environment, Enterprise and Development), Prof. Ian Rowlands (School of Environment, Resources and Sustainability), Prof. Olaf Weber (School of Environment, Enterprise and Development), Prof. Heather Douglas

(Philosophy), Prof. Joachim Knebel (Karlsruhe Institute of Technology), Prof. Orestis Terzidis (Karlsruhe Institute of Technology), Prof. Armin Grunwald (Karlsruhe Institute of Technology), Prof. Veit Hagenmeyer (Karlsruhe Institute of Technology), Prof. Hartmut Schmeck (Karlsruhe Institute of Technology), Prof. Marc Hiller (Karlsruhe Institute of Technology), Prof. Thomas Leibfried (Karlsruhe Institute of Technology), Prof. Isabelle Suedmeyer (Karlsruhe Institute of Technology), Prof. Ioannis Lestas (University of Cambridge), Prof. Robert Doubleday (University of Cambridge), Prof. Hisham Zerriffi (University of British Columbia), Prof. Fred McBagonluri (Ashesi University), Prof. AbuBakr Bahaj (University of Southampton), Prof. Malcolm McColloch (University of Oxford), Prof. David Howey (University of Oxford), Prof. Charles Monroe (University of Oxford), Prof. Taha Selim Ustun (Carnegie Mellon University), Prof. Jouko Lampinen (Aalto University), Prof. Peter Lund (Aalto University), Prof. Martina Schäfer (Technical University of Berlin), Prof. Ortwin Renn (University of Stuttgart), Prof. Lucia Rodriguez (Columbia University), Prof. Pieter Van Der Zaag (Delft University of Technology & UNESCO-IHE), Prof. Ameena Al-Sumaiti (Masdar Institute of Science and Technology), Prof. Khanjan Mehta (Penn State University),

**Industry Partner(s) and Other Organization(s):** Waterloo Global Science Initiative, Centre for Global Equality, Practical Action, Smart Villages Initiative, Mobisol, ME SOLshare Ltd., Boond, Trama TecnoAmbiental, ENventure, Discourse Media, SunFarmer, Lumos Energy, Global Off-Grid Lighting Association (GOGLA), and Next Einstein Forum.

**Other Academic Institution(s):** Karlsruhe Institute of Technology, University of Cambridge, University of British Columbia, Ashesi University, University of Southampton, University of Oxford, Carnegie Mellon University, Aalto University, Technical University of Berlin, University of Stuttgart, Columbia University, Delft University of Technology & UNESCO-IHE, Masdar Institute of Science and Technology, and Penn State University.

**Funding Agencies:** MacArthur Foundation

**Grant Name:** 100&Change Grant

**Status:** Not Approved (2016)

**Total Project Value:** \$100,000,000

## 2. A Compressed Air Energy Storage (CAES) - Demonstration Project

**Abstract:** NRStor Inc. has a proposed 1.75MW, no carbon CAES demonstration project in Goderich, funded in part by the ON IESO. This is an exceptional opportunity to develop applied engineering aspects of CAES (cavern and ground response, thermal issues, cyclic effects, etc.). Waterloo leads a government-funded CAES research project with industry partners (OPG, NRStor, Union Gas, Compass Minerals, HydroOne) developing CAES and grid management models integrating geomechanics, power and mechanical engineering. The model-oriented project ends in 2018. Field work with NRStor's project allows testing models (calibration), emplacing monitoring arrays (cheap sensors we developed), addressing heat management issues, and advancing this potentially key ON technology.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** Ontario Research Fund

**Grant Name:** Ontario Research Fund – Research Excellence (ORF-RE)

**Status:** Submitted – pending decision

**Total Project Value:** \$12,000,000

### 3. Intermediate Grade Geothermal Energy (IGGE) for Decarbonization

**Abstract:** This project will provide ON access to deep geothermal energy to further decarbonize its energy usage and meet critical energy needs in the north. We will integrate Intermediate Grade Geothermal Energy (IGGE) and Thermal Energy Storage (TES) into a viable technology for communities and industry. In northern ON, IGGE may replace diesel, is of lower risk (no transport), has no Carbon(C) emissions, and is amenable to co-generation (power + heat) in a region where heat is valuable, infrastructure is lacking, and wind and solar are weak in the cold months. High-grade geothermal is absent in ON; below 3 km, IGGE is available (Grasby et al, 2012). The goal is C-free energy for large-volume, low-grade heating and small-scale power for communities and industry on an annual cycle. IGGE and TES can provide reliable, robust, and resilient energy.

**Academic Investigator(s):**

- Main PI: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** Ontario Research Fund

**Grant Name:** Ontario Research Fund – Research Excellence (ORF-RE)

**Status:** Submitted – pending decision

**Total Project Value:** \$12,000,000

### 4. Clean Technology Smart Grid R&D Consortia

**Abstract:** Smart grid in the energy sector is defined as newer sustainable energy generation technologies being incorporated into existing electrical grid systems, using advanced ICT communications systems to increase the efficiency, reliability and transmission of power through grid assets; electricity meeting ICT. Canada is one of the most advanced countries in the world in terms of its smart grid development and we have the market, energy policy drivers and regulatory frameworks in place to support economic growth in this sector. Waterloo, under the leadership of the Principal Investigator Dr. Jatin Nathwani, the Executive Director of WISE, will conduct research with companies, with high-growth potential, to develop next generation smart grid technologies that will become part of the IP portfolios of the companies as they move technology into the market. WISE and ArcTern Ventures will work together to develop the research projects identified with matching funds to be provided by ArcTern. The companies will invest in the research at Waterloo, to be matched and leveraged by the investment from MBDA. Jatin, Nathwani, as the Principal Investigator will participate in the research projects working with each specific research group at Waterloo and the

ArcTern counterparts. The core competencies of ArcTern lies in deep technology and emerging fields of science, from advanced materials to artificial intelligence, which apply broadly to sector of renewable energy with respect to smart grid applications, internet of things, electric vehicle technology networks, information and communication technology infrastructure, etc.

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)
- Co-PIs: Prof. Claudio Canizares (Electrical and Computer Eng., UW), Prof. Mehrdad Kazerani (Electrical and Computer Eng., UW), Prof. Catherine Rosenberg (Electrical and Computer Eng., UW), Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW), Prof. Ehab El-Saadany (Electrical and Computer Eng., UW), Prof. Magdy Salama (Electrical and Computer Eng., UW), Prof. Siva Sivorthaman (Electrical and Computer Eng., UW), Prof. Kumaraswamy Ponnambalam (Systems Design Eng., UW), Prof. Yuning LI (Chemical Eng., UW), Prof. Hany Aziz (Electrical and Computer Eng., UW), Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), Prof. Eric Croiset (Chemical Eng., UW), Prof. Armaghan Salehian (Mechanical and Mechatronics Eng., UW), Prof. Srinivasan Keshav (Cheriton School of Computer Science), Prof. Linda Nazar (Chemistry),

**Industry Partner(s):** MBDA France, Capital Hill Group, ArcTern Ventures, Morgan Solar, Polar Sapphire, Smarter Alloys, and Green Mantra

**Other Academic Institution(s):** N/A

**Funding Agencies:** Federal Government, NSERC, and OCE

**Grant Name:** N/A

**Status:** Submitted - pending decision

**Total Project Value:** Est. \$6,720,000

## 5. Demonstration and Analysis of Net Zero Solar Powered Electric Vehicle Charging Stations

**Abstract:** The proposed demonstration project directly addresses the EIP Program's objective which is to support energy technology innovation to produce and use energy more cleanly and efficiently. This project will first, in Ontario, demonstrate and characterize in detail the net zero concept of solar powered EV charging stations. It utilizes the renewable energy to reduce in principle 100% of the carbon footprint and other greenhouse gases for EV charging. Smart energy management tools will be implemented to achieve more efficient and secure energy conversion and transfer.

**Academic Investigator(s):**

- Main PI: Prof. John Wen (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** Proponent, Canadian Solar Inc., Electrefy Inc., Sustainable Waterloo Region, CommunityCarSharing, Blackberry, Symanta, Canadian Standards Association (CSA) Group, Waterloo North Hydro (WNH),

**Other Academic Institution(s):** N/A

**Funding Agencies:** Natural Resources Canada (NRCan)

**Grant Name:** Energy Innovation Program (EIP)

**Status:** Not Approved (2016)

**Total Project Value:** \$4,960,800

## 6. Mag-Tech Motor

**Abstract:** The program's objective is to support energy technology to produce and use energy more cleanly and efficiently. Specifically, the Mag-Tech Motor would support the strategic priority of renewable energy, smart grids and storage. The Mag-Tech Motor utilizes magnetic force generated from the positioning of permanent magnets to produce a constant stream of kinetic energy that is harnessed into electrical energy by the affiliated generator for immediate consumption, or, stored for use at a later date.

### Academic Investigator(s):

- Main PI: Prof. Behrad Khamesee (Mechanical and Mechatronics Eng., UW)
- Co-PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** Mag-Tech Renewable Energies Inc. (Mag-Tech was the main applicant)

**Other Academic Institution(s):** N/A

**Funding Agencies:** Natural Resources Canada (NRCan)

**Grant Name:** Energy Innovation Program (EIP)

**Status:** Not Approved (2016)

**Total Project Value:** \$4,256,400

## 7. Consultancy to Deploy Decentralized, Sustainable Power Systems in Health Facilities in Africa

**Abstract:** The goal of the project is to enable improved delivery of health services – primarily for maternal and child health – in primary health care facilities, through improved access to modern, affordable, and sustainable electricity services. Speaking on behalf of the UN Foundation, Pete Ogden, Vice President for Energy, Climate, and the Environment, said: “Sustainable and reliable electricity is critical to providing quality health services, but is often unavailable or insufficient at the primary health care level. With support from the UK government, the UN Foundation is working to demonstrate the importance of the energy-health nexus, through the implementation of this project and our broader work with partners and Sustainable Energy for All. With this project, we will continue to show how Sustainable Development Goal 7 – ensuring access to affordable, reliable, sustainable and modern energy for all – can facilitate progress on the other SDGs.”

### Academic Investigator(s):

- Main PI: Prof. Jatin Nathwani (Mechanical and Mechatronics Eng., UW)
- UW Co-PIs: Prof. Srinivasan Keshav (computer Science), Prof. Claudio Canizares (ECE), Prof. Mehrdad Kazerani (ECE), Nigel Moore (WISE)

**Industry Partner(s):** Trama TecnoAmbiental

**Other Academic Institution(s):** The Karlsruhe Institute of Technology, The University of California, Berkeley, Cambridge University, The University of Southampton, Universidad de Chile

**Funding Agencies:** United Nations Foundation, UK Department for International Development (DFID)

**Grant Name:** Consultancy to Deploy Decentralized, Sustainable Power Systems in Health Facilities in Africa

**Status:** Not Approved (2015)

**Total Project Value:** \$2,500,000

## 8. Energy Harvesting and Green Energy Technologies for Internet of Things

**Abstract:** The proposed research will be focused on training highly qualified personnel in the area of Natural resources and energy. The research will focus on several aspects of renewable and green energy technologies such as smart material-based harvesting technologies, low-power or zero-power energy monitoring systems, other forms of renewable energy generation such as solar, as well as energy storage.

**Academic Investigator(s):**

- Main PI: Prof. Armaghan Salehian (Mechanical and Mechatronics Eng., UW)
- Co-PIs: Prof. Raafat Mansour (Electrical and Computer Eng., UW), Prof. Catherine Rosenberg (Electrical and Computer Eng., UW), Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW), Prof. Srinivasan Keshav (Cheriton School of Computer Science), Prof. John Long (Electrical and Computer Eng., UW), Prof. Peter Levine (Electrical and Computer Eng., UW), Prof. Norman Zhou (Mechanical and Mechatronics Eng., UW), Prof. Farid Golnaraghi (Simon Fraser University), Prof. Behraad Bahreini (Simon Fraser University), and Prof. Ridha Ben Mrad (University of Toronto)

**Industry Partner(s):** Skyworks Solutions Inc., Kapik, Sensor Technology Ltd., Fibics, Burloak, Intel, Teledyne DALSA, Innovata Labs, Cisco Systems, Onion (IoT manufacturer), Greater Sudbury Utilities, Celestica, Canada Solar, SNC Lavalin Inc., Waterloo North Hydro, Alpha Technologies, and BC Hydro

**Other Academic Institution(s):** Simon Fraser University, and University of Toronto

**Funding Agencies:** NSERC

**Grant Name:** NSERC Collaborative Research and Training Experience (CREATE) Program

**Status:** Not Approved (2017)

**Total Project Value:** \$1,650,000

## 9. Smart Graphene-Based Composites for High-Energy and Self-Healing Lithium-Ion Batteries

**Abstract:** Lithium based rechargeable battery technologies have become the focal point of research to fulfill the requirements of electric vehicles (EVs). The most commonly used LIBs utilize graphite and transition metal oxides as anode and cathode materials, respectively. Such a battery can only provide an energy density of ~150 Wh kg<sup>-1</sup> due to the low specific capacities of the electrode materials. To meet the requirements of both high energy and power density with cycle durability of modern EVs, the next generation of active material is necessary.

The proposed project will specifically address critical technical barriers to the improved performance including energy density, cycling stability and safety as well as power density of lithium ion batteries, while strategically lowering the cost of commercial production by designing and developing Smart graphene-based nanostructured composites for automotive applications. The novel graphene-based composite materials can overcome the existing challenges of energy density, cycling life, and safety as well as cost of current lithium-ion batteries. This work entails a unique approach in the development of highly porous graphene materials based Si nanoparticles to create a unique 3D architecture. Another approach is development of practical battery from self-healing functionalized smart electrode fabrication for safe operation of LIBs.

From the development of proposed research, it is expected that utilizing high quality modified graphene and silicon/graphene composite nanomaterials will efficiently overcome the current challenges of commercial electrodes, which will play the key role in improving the energy density, cycling stability, safety and power performance of LIBs. It can be predicted that the success of the proposed high-performance LIBs will reduce both toxic and greenhouse gas emissions by improving energy efficiency and integrating with transportation and green energy systems including solar and wind energy, and this will provide significant social and environmental benefits to all Canadians. The expertise developed and the training of HQP in this research project will contribute to expanding industrial and business activities and enterprises in Canada.

**Academic Investigator(s):**

- Main PI: Prof. Zhongwei Chen (Chemical Eng., UW)

**Industry Partner(s):** Canadian Standards Association (CSA)

**Other Academic Institution(s):**

**Funding Agencies:** NSERC

**Grant Name:** NSERC Collaborative Research and Training Experience (CREATE)

**Status:** Not Approved (2016)

**Total Project Value:** \$1,650,000

## 10. Developing Intermediate-Grade Geothermal Energy in Canada

**Abstract:** There are only a few sites in Canada in British Columbia and the Yukon with reasonable access to high-grade geothermal energy. However, at depths of 4-8 km in the igneous rocks that underlie all of Canada there are huge quantities of intermediate-grade geothermal energy (IGGE). New rapid drilling technologies based on impact drilling using polycrystalline diamond bits promise to revolutionize our ability to economically drill boreholes to access this IGGE, and new concepts in hydraulic fracturing will allow linking of parallel horizontal wells at depth to achieve suitable rates of energy recovery. These developments will open the possibility of widespread use of zero-carbon IGGE, but its advantages will be most apparent in the Canadian Arctic, where the only reliable source of energy is currently fossil fuels, usually shipped in at great expense. The Arctic (indeed, most of Canada) needs massive amounts of low-grade heat for homes and buildings. IGGE can provide this, and it appears that it can also provide electrical power.

The research project at Waterloo will explore three large themes: first, accessing the IGGE through drilling, controlled hydraulic fracturing and fluid circulation; second,

understanding and simulating the rock mechanics behavior at depth as the rock mass is cooled; and third, developing better ways to extract some electrical power from the IGGE fluids so that power plus heat can be provided to these remote communities. If a complex but clear technology for IGGE development is established in the North, it will almost certainly become economic in the south of Canada as we seek to reduce greenhouse gas emissions from fossil fuels and expand our energy sources. IGGE is not invasive at the surface, in contrast to solar and wind power, and can provide the equivalent of electrical station base load in terms of steady heat and some power, but at a much more modest scale (e.g. total rate of 40-80 MW).

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)
- Co-PI: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), and Prof. Dipanjan Basu (Civil and Environmental Eng., UW)

**Industry Partner(s):** Borealis Geopower, Egmond Associates Ltd., Dascan Groundheat Energy Services Ltd., and Centre for Excellence in Mining Innovation (CEMI)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Strategic Partnership Grants for Projects

**Status:** Not Approved (2016)

**Total Project Value:** \$891,750

## 11. Decarbonization of Energy: Geothermal and Energy Storage

**Abstract:** Energy decarbonization and energy storage are key elements in the energy future of the world. In Canada, the cold climate, particularly in the north, means that a great need for reliable heat and electrical power exists, and right now, 100% of this is generated by diesel fuel, imported at great cost from Quebec City and Edmonton. Indigenous communities are dependent on this single, costly, carbon-rich energy source that is also a fire hazard and a potential pollutant. Deep geothermal energy and thermal energy storage in deep geothermal rock masses promises to provide heat and power to remote communities, enhancing their life quality and opening new possibilities for community activities.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)
- Co-PIs: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), Prof. Dipanjan Basu (Civil and Environmental Eng., UW), Prof. Andrew Swanson (Cape Breton University), Martin Mkandawire (Cape Breton University), and Annamarie Hatcher (Cape Breton University)

**Industry Partner(s):** NRStor, Egmond Associates Ltd., and Centre for Excellence in Mining Innovation

**Other Academic Institution(s):** Cape Breton University

**Funding Agencies:** NSERC

**Grant Name:** NSERC Strategic Partnership Grants for Projects

**Status:** Not Approved (2017)

**Total Project Value:** \$600,000

## 12. Cased Wellbore Integrity Assurance

**Abstract:** This Strategic Grant (SG) will develop better technology for mitigating fluid migration around Oil&Gas (O&G) wells - dominantly natural gas seepage from active and decommissioned wells. In addition to generating new knowledge and highly-qualified persons (HQPs), a novel down-hole logging tool is to be developed to more accurately determine the condition of the cement and rock behind steel casing, as well as evaluate the condition of the steel itself. Implementation of the logging tools and the models we will develop will reduce wellbore leakage and greenhouse gas emissions, identify zones for mitigation action, and provide a vastly improved quality assurance approach to wellbore integrity evaluation and maintenance. Given that there are 550,000 O&G wells in Canada (and five million more around the world), and that quality assurance for newly installed wells and wells being readied for decommissioning would readily benefit from these developments, the potential environmental and commercial impact could be substantial.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)
- Co-PIs: Prof. Giovanni Cascante (Civil and Environmental Eng., UW), Prof. Walter Illman (Earth and Environmental Sciences, UW)

**Industry Partner(s):** Scientific Drilling International Inc. (Canada)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Strategic Partnership Grants for Projects

**Status:** Not Approved (2017)

**Total Project Value:** \$600,000

## 13. Corrosion Assessment of Reinforced Concrete Structures Using Passive Magnetic Inspection (PMI) Methods

**Abstract:** Selecting the optimum time for infrastructure replacement and repair is an on-going challenge for transportation authorities. The corrosion state of reinforcing steel (rebar) in roadways, bridge decks and structures (e.g. parking buildings) is a major factor in decisions to repair or replace, and a quantitative non-destructive assessment of the corrosion state of rebar remains challenging. Trials of a passive magnetic method on pipelines in Iran and China have proven successful in identifying corrosion locations using a simple transit method (Mahbaz et al. 2011). The method has great potential in non-destructive testing of rebar corrosion. Support of a research project with a student (SeyedBijan Mahbaz), one of the developers of this method in Iran, presents an opportunity to benefit from several years of experience immediately, greatly increasing the chances of a successful project.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)

**Industry Partner(s) and Other Organization(s):** Ontario Ministry of Transportation

**Other Academic Institution(s):** N/A

**Funding Agencies:** Sustainable Development Technology Canada (SDTC)

**Grant Name:**

**Status:** Not Approved (2016)

**Total Project Value:** \$500,000

#### 14. Strengthen the Engineering Capacity of Canada's Energy Companies to Deliver Clean Energy Technology Innovations

**Abstract:** A key purpose of the research focus is to develop a rigorous framework and the required quantitative metrics for understanding the linkages between innovation and environmental sustainability in the energy sector. A primary objective is to bring to bear the full capacity of engineering research methods that provide insight for decision-makers to shape business performance in alignment with corporate social responsibility and the necessary tools for global-scale applications.

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Discovery

**Status:** Not Approved (2016)

**Total Project Value:** \$300,500

#### 15. EV Charging Infrastructure on UW Campus – Electric Vehicles and Additional EV Chargers

**Abstract:** WISE initiative with the Advancement team of Faculty of Arts

**Academic Investigator(s):**

- Main PI: N/A

**Industry Partner(s):** Cox Automotive

**Other Academic Institution(s):** N/A

**Funding Agencies:** N/A

**Grant Name:** N/A [Donation]

**Status:** Not Approved (2017)

**Total Project Value:** \$250,000

#### 16. Intermediate-Grade Enhanced Geothermal Systems (WatTHERM)

**Abstract:** WatTHERM is an engineering research and demonstration group at the University of Waterloo. Our R&D project for geothermal energy in Ontario focuses on analysis and field experiments to show heat storage energetics in geological media. Two wellbores will be drilled, cased and cemented at a depth of 100 m. Heat will be input to one well, and the adjacent well, offset by three metres, will serve as a monitor well. We

will analyze how effectively heat is stored in the rock, and how we can extract it efficiently. Results will allow us to determine thermal characteristics of a rock mass in a real configuration, as well as testing the reliability of mathematical models we are developing. This knowledge and capability is an important part of designing heat storage systems in the future.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)
- Co-PIs: Prof. Yuri Leonenko (Earth and Environmental Sciences, UW), and Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** GeoSmart Energy Inc., NRStor, and Scientific Drilling International (Canada) Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** Ontario Centres of Excellence (OCE)

**Grant Name:** Ontario's Solutions 2030 Challenge

**Status:** Not Approved due to Disqualification on grounds of not securing matching funds (2017)

**Total Project Value:** \$250,000

## 17. Thermal Energy Storage for Integration of Renewable Energy Sources in Microgrids

**Abstract:** Increasing concerns regarding greenhouse gas (GHG) emissions and continuous reduction in the cost of Renewable Energy Sources (RES) are encouraging the deployment of renewablebased Distributed Energy Resources (DERs) and Demand Side Management (DSM) options in power systems. The proposed research work will therefore be of direct benefit to the thermal energy storage (TES) and RES-based microgrid industry and operators, through the study and demonstration of thermal storage integration in microgrids to facilitate significant penetration of variable RES, based on balancing heating and cooling sources and loads with electrical demand and surplus supply.

**Academic Investigator(s):**

- Main PI: Prof. Claudio Canizares (Electrical and Computer Eng., UW)
- Co-PIs: Prof. Kankar Bhattacharya (Electrical and Computer Eng., UW)

**Industry Partner(s):** Canadian Solar Inc.

**Other Academic Institution(s):** Karlsruhe Institute of Technology

**Funding Agencies:** International Energy Agency (IEA)

**Grant Name:** Technology Collaboration Programme on District Heating and Cooling including Combined Heat and Power: Call for Proposals – Annex XII

**Status:** Not Approved (2016)

**Total Project Value:** \$196,430

## 18. District Energy Data Collection, System Optimization and Readiness Toolkit

**Abstract:** The University of Waterloo has been engaged by a private firm to provide research related to the development of a sustainable, very low energy (or energy neutral), 13 acre mixed residential and commercial development. District heating implementations, utilizing a variety of energy sources and distribution schemes have been proposed as a means of achieving these goals. The client is a medium-sized municipality in southern Ontario.

### Academic Investigator(s):

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)
- Co-PIs: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW), Prof. Paul Parker (School of Environment, Enterprise, and Development, UW), Prof. Goretty Dias (School of Environment, Enterprise, and Development, UW), Prof. Amer Obeidi (Systems Design Eng., UW), Prof. John D. McLennan (University of Utah), and Prof. Sun Feng (China University of Petroleum)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** University of Utah and China University of Petroleum

**Funding Agencies:** International Energy Agency (IEA)

**Grant Name:** Technology Collaboration Programme on District Heating and Cooling including Combined Heat and Power: Call for Proposals – Annex XII

**Status:** Not Approved (2016)

**Total Project Value:** \$195,500

## 19. Impact of Level 2 and Level 3 Electric Vehicle (EV) Charging Stations on the Electrical Distribution System, on the Environment, and on Consumer Uptake of Electric Vehicles

**Abstract:** The Level 3 charging station is the centrally necessary component of this RTI proposal. As explained in more detail in the proposal, without the Level 3 charger the interest of Local Distribution Companies (LDCs) in this research is greatly diminished. This is because, for example, the sizing of electricity grid transformers to date does NOT consider the charging of vehicles, certainly not Level 3 charging, or even extensive Level 2 charging. The Level 2 chargers are a necessary research component that complement the Level 3 charger as they will provide comparison data, and are very relevant for human behaviour and policy reasons as they are expected to be the most popular dedicated EV chargers for the next decade or more.

### Academic Investigator(s):

- Main PI: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW)
- Co-PI: Prof. Jatin Nathwani (Management Sciences, UW), Prof. Nasser Azad (Systems Design Eng., UW), Prof. Michael Fowler (Chemical Eng., UW), Prof. Weihua Huang (Electrical and Computer Eng., UW), Prof. Sheshakamal Jayaram (Electrical and Computer Eng., UW), Prof. Mehrdad Kazerani (Electrical and Computer Eng., UW), Prof. Amir Khajepour (Mechanical and Mechatronics Eng., UW), Prof. Kumaraswamy Ponnambalam (Systems Design Eng., UW), Prof. Armaghan Salehian (Mechanical and Mechatronics Eng., UW), Prof. Sherman Shen

(Electrical and Computer Eng., UW), Prof. Lan Wei (Electrical and Computer Eng., UW), Prof. Ramandan El Shatshat (Electrical and Computer Eng., UW), Prof. John McPhee (Systems Design Eng., UW), Prof. Steven Young (School of Environment, Enterprise and Development), Prof. Paul Parker (School of Environment, Enterprise and Development), and Prof. Ranjini Jha (School of Accounting and Finance)

**Industry Partner(s) and Other Organization(s):** Canadian Standards Association (CSA), Guelph Hydro, Region of Waterloo, and Waterloo North Hydro (WNH)

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Research Tools and Instruments (RTI)

**Status:** Not Approved (2016)

**Total Project Value:** \$150,000

## 20. Socio-Economic Implications of Energy Decarbonization Efforts on the Less Developed World - A System Dynamics Modelling Approach

**Abstract:** The study seeks to address the questions of effectiveness of existing decarbonisation policy instruments, the multi-faceted socio-economic implications and effects of energy decarbonisation on the less developed world, and which set of policy options and types can be recommended to achieve a relatively balanced and sustainable energy decarbonisation in the shortest time with minimum negative impact? The study is attempting to identify and address the system-based socio-economic factors that would require a mosaic integration approach to sustainability in order to make clean and affordable energy services available in the very near future to citizens of the energy-deficient world.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Civil and Environmental Eng., UW)
- Co-PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A

**Other Academic Institution(s):** Obafemi Awolowo University, Ile-Ife, Osun, Nigeria

**Funding Agencies:** NSERC, SSHRC, and CIHR IRSC

**Grant Name:** Banting Postdoctoral Fellowships

**Status:** Not Approved (2016)

**Total Project Value:** \$140,000

## 21. Sustainable Management of Oil Sands (OS) Using System Dynamics: A Case Study of Three Continents

**Abstract:** The study seeks to address the question of whether OS development in three continents (North America, South America, and Africa) has a potential for sustainability, and to what extent? It also considers the discourse on whether or not OS development will impact the global settings positively or negatively, in terms of sustainable management? Lastly, it also intends to answer the question of which policy options, and types can be recommended to achieve sustainable OS resource development?

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Civil and Environmental Eng., UW)
- Co-PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** N/A**Other Academic Institution(s):** OP Jindal Global University, New Delhi, India**Funding Agencies:** NSERC, SSHRC, and CIHR IRSC**Grant Name:** Banting Postdoctoral Fellowships**Status:** Not Approved (2015)**Total Project Value:** \$140,000**22. Geotechnical Design Optimization and Resiliency Analysis of Subway Infrastructure in Toronto**

**Abstract:** Integrating sustainability into design and construction is becoming a priority for the geotechnical and civil engineering industries. Currently, geotechnical design practice is overly conservative, requiring excessive use of materials and resulting in excessive safety measures. The proposed research will provide RWH with a design tool (software) with which subway structure design will be optimized from geotechnical safety, serviceability, as well as, material use and resilience points of view. RWH engineering will gain critical understanding of the implications of conservative geotechnical designs in terms of environmental and economic impacts. The company will be able to provide customers with optimized designs that balance sound engineering with economic, environmental, and resilience aspects.

**Academic Investigator(s):**

- Main PI: Prof. Dipanjan Basu (Civil and Environmental Eng., UW)

**Industry Partner(s):** RWH Engineering Inc.**Other Academic Institution(s):** N/A**Funding Agencies:** Ontario Centres of Excellence (OCE), and NSERC**Grant Name:** Voucher for Innovation and Productivity II (VIP II), and NSERC Engage Grant**Status:** Submitted – pending decision**Total Project Value:** \$65,000**23. Developing Intermediate Grade Geothermal Energy for Arctic Canada**

**Abstract:** Advances in drilling, hydraulic fracturing and power extraction in the last decade make deep intermediate grade geothermal energy viable in the north, where all power and heat are generated with diesel fuels. The ENGAGE grant will allow a quantitative assessment of systems and costs to develop this energy source for communities, and also for military sites and resource projects. Working with a company specializing in geothermal systems will allow delineation of the research and development needs to bring this energy source to the people and projects in the Arctic that could benefit greatly.

**Academic Investigator(s):**

- Main PI: Prof. Maurice Dusseault (Earth and Environmental Sciences, UW)

**Industry Partner(s):** Egmond Associates Ltd.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage

**Status:** Not Approved (2016)

**Total Project Value:** \$37,500

#### **24. Numerical Study of an Innovative Wind Tower Design for Natural Ventilation and Passive Cooling in Residential and Commercial Buildings**

**Abstract:** This proposed research is conceived as part of new research collaboration between Dr. Roydon Fraser (Professor, University of Waterloo) and InspecTerra Inc. to conduct a research project entitled “Numerical Study of an Innovative Wind Tower Design for Natural Ventilation and Passive Cooling in Residential and Commercial Buildings”. The objective of this research project is to create a simulation model for a wind tower and use this model to optimize a window for a medium to large commercial or residential building in Ontario. In this project, Dr. Fraser and his research team will perform different tasks for investigation and analysis of the ventilation and thermal performance of an innovative design of wind tower to utilize in residential and commercial buildings.

**Academic Investigator(s):**

- Main PI: Prof. Roydon Fraser (Mechanical and Mechatronics Eng., UW)

**Industry Partner(s):** InspecTerra Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Status:** Submitted – pending decision

**Total Project Value:** \$37,000

#### **25. Energy Engineering and Design Optimization of Thermal Energy Storage Systems for One of Three Specific Residential Dwellings in a Yukon Community**

**Abstract:** In the proposed project, Dr. Claudio Canizares (Professor and Hydro One Endowed Chair) from the Department of Electrical and Computer Engineering at University of Waterloo will collaborate with RESTCo. to address the engineering research problem of clean, efficient, and reliable electrical and thermal supply, including Electric Thermal Storage (ETS) systems, for clusters of new residential homes in the community of Burwash located in northern Ontario, south of Sudbury.

The main objective of the proposed research work is to study and develop techniques and tools for the optimal design of efficient, clean, and reliable electrical and thermal

energy supply systems for clusters of new homes in northern communities in Canada, using the community of Burwash as the test site, and considering ETS systems to minimize the use of battery-based ESS to allow the proper management of RE sources.

**Academic Investigator(s):**

- Main PI: Prof. Claudio Canizares (Electrical and Computer Eng., UW)

**Industry Partner(s):** RestCo.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage Grant

**Status:** Not Approved (2017)

**Total Project Value:** \$37,000

## 26. Life Cycle Cost Modeling of VoltaAir's Electric Auxiliary Power Units

**Abstract:** This research proposal is built with partnership with VoltaAir Technology Inc. and primarily aims to develop a Life Cycle Cost modeling platform for VoltaAir's battery powered A/C-R system. With an exclusive focus on advanced Lithium Ion Batteries, the scope of this project is to develop and employ Life Cycle Cost models for battery powered Auxiliary Power Units (APUs) in commercial vehicles. The objective is to optimize battery performance, environmental foot prints, and life cycle cost based on climate and load conditions and to analyze idle-free modes of new generation VoltaAir's no-idle refrigeration systems. This R&D effort is further enabling the company to solve more sophisticated battery cost-performance optimization problems related to battery management system, taking into account the stochastic nature of certain exogenous factors (charging cost, fuel cost, customer demand, emission costs, and required performance characteristics).

**Academic Investigator(s):**

- Main PI: Prof. Jatin Nathwani (Management Sciences, UW)

**Industry Partner(s):** VoltaAir Technology Inc.

**Other Academic Institution(s):** N/A

**Funding Agencies:** NSERC

**Grant Name:** NSERC Engage

**Status:** Not Approved (2015)

**Total Project Value:** \$33,000

## **3.3 Influence: Mobilizing Knowledge for a Sustainable Society**

## ***Influence:*** **Mobilizing Knowledge for a Sustainable Society**

By publicizing our work, engaging with the media, and organizing a wide variety of events that bring our members together with external organizations and the public, we help to inform a broader and more constructive dialogue around sustainable energy.

WISE events create an environment in which leading energy experts can constructively share insights on key issues and collaboratively pursue impactful follow-up activities. By hosting these events, WISE provides our members with the networking opportunities to inspire innovative ideas that benefit their research. We take care of everything, from managing logistics to securing funds for promotion, and follow-up. This leaves our members free to focus on what they do best: advancing impactful research.

Our annual events provide consistent opportunities for interaction between our members and their stakeholders. These include the WISE Energy Day (held every spring and open to anyone from across the UW community) Technology Innovation and Policy Forum (every fall, held in partnership with the Canadian Council for Clean Reliable Electricity), and the Resource Recovery Partnership Workshop (a summertime gathering of researchers, industry players and governmental and non-governmental organizations engaged in the field of waste management and energy recovery). Through the AE4H initiative, WISE has also developed a unique event format – the innovation lab – which provides an interactive setting for members of this global consortium to develop joint projects in areas of shared interest. The first of these was held in Germany in 2017, resulting in a number of productive outputs including a Special Issue of the prestigious journal IEEE Proceedings. The second major innovation lab will take place in June 2019, bringing 50+ global leaders to Waterloo to advance the fight against global energy poverty.

As an outward face of the University, we also value the creation of opportunities for members of the public to learn about sustainable energy. To this end, over the past 5 years WISE has hosted 65 public lectures on campus, approximately one every month. Public lectures allow our members to share their research with a wider audience, allow us to bring in renowned experts to campus to interact with our faculty researchers and students, and give members of the general public opportunities to learn from and interact with sustainable energy researchers.

**“Public lectures, major conferences, symposia and other outreach events organized by WISE provide a window to the world of energy, as well as strong motivation to our students and faculty members to engage in addressing complex societal problems”**

Keith W. Hipel

University Professor, Systems Design Engineering

President, Academy of Science, Royal Society of Canada

Officer of the Order of Canada



**I am clearly a strong supporter of WISE, it has the potential to continue to grow and become a strong body in Canada, informing the policy makers with science-based information to help them deliver good legislation to Federal and Provincial Legislatures.**

Maurice B. Dusseault

Professor of Earth Sciences, PhD, PEng

Department of Earth and Environmental Sciences



**“WISE has a unique ability to both delve into the more complex questions related to Canadian energy while also making their findings accessible and more generally useful to the broader range of stakeholders we seek to engage.”**

Colin Anderson

Chair

Energy Council of Canada

## 3.3.1 Conferences and Workshops

### WISE Energy Day

Over the past 5 years, WISE has hosted an 'Energy Day' on the UW campus every year. The one-day event sees academics, industry, government and NGO experts come together to share insights and optimism for the future of the clean energy sector in Canada and the world. It is open and free to students, faculty-members and the public. . Over 100 participants attend WISE Energy Day every year.

Energy Day provides an opportunity to highlight energy research at UW energy research through presentations, Q+A, posters, panel discussions and the opportunity to network with like-minded individuals.

Energy Day 2013-2018 have covered the following topics:

#### **Energy Day 2013, October 4, 2013**

- Panel 1: Shale Gas Development: The Use and Protection of Water
- Panel 2: The Need for Innovation in Energy Storage

#### **Energy Day 2014, October 17, 2014**

- Panel 1: Energy Entrepreneurship
- Panel 2: The Future of Energy Service Delivery

#### **Energy Day 2016, March 30, 2016**

- Panel 1: Geothermal Energy in Canada: How Can Research Shape Market Outcomes?
- Panel 2: Electric Mobility Infrastructure: Is it a Technology or a Business Model Challenge?
- Panel 3: Social & Policy Issues of De-Carbonizing the Canadian Energy Economy: Is there a Clear Path?

#### **Energy Day 2017, March 30, 2017**

- Panel 1: Energy Transitions for a Decarbonized Economy: How Fast and at What Cost?
- Panel 2: Low Energy Green Buildings: What can innovation do?
- Panel 3: Energy Access for Canada's Remote First Nations Communities: If Not Now, When?

### **Energy Day 2018, March 27, 2018**

- Panel 1: Access to Clean Energy for All: Is Innovation the Problem?
- Panel 2: Getting to a Low Carbon World: Capture or Utilize?
- Panel 3: Blockchain in the Energy Sector: Bust or Bonanza?

## **Technology Innovation and Policy Forum**

Since 2016, WISE has partnered with the Council for Clean & Reliable Energy (CCRE) to organize the Technology Innovation and Policy Forum, an annual event with the goal of helping shape the next generation smart energy solutions and providing a direct link between cutting edge energy research at Waterloo and the Canadian energy policy community.

Each year, the forum brings together technology developers and innovators, leading researchers and entrepreneurs, industry thought leaders, and policy makers to share their insights on how to reach the convergence of policy development with technology advances via an innovation showcase including lab tours, networking sessions, poster and table presentations, panel discussions and presentations, and keynote talks.

The success of the first three Technology Innovation & Policy Forums has allowed WISE to secure sponsorship from relevant institutions that will allow the event to continue for future years.

Forum topics have included:

### **Technology Innovation & Policy Forum 2016, November 24, 2016**

*Event title: Microgrids & Distributed Energy: Is there a revolution in the making?*

- Panel 1: Technology and Disruptive Innovation
- Panel 2: Policy Alignment - Financing, Business Models and Regulatory Construct

### **Technology Innovation & Policy Forum 2017, November 9 2017**

*Event title: Disruptive Innovation over the Wires: Models for Success*

- Panel 1: Is Technology Disruption Driven by Economics?
- Panel 2: Financing Business Models: The Good, the Bad and the Ugly

## Technology Innovation & Policy Forum 2018, November 7 2018

Event title: *Unlocking Energy Innovation for a 'Low Cost-Low Carbon' Economy*

- Panel 1: The Promise and Perils of Technology Disruption
- Panel 2: Financing Energy Businesses: The Good, the Bad and the Ugly

Partners:



## Resource Recovery Partnership Workshops

Starting in 2014, the Canadian Plastics Industry Association has partnered with WISE to host an annual workshop on the present and future of waste management and resource recovery research in Canada.

These invitation-only events have brought together key stakeholders from government, industry and academia and encouraged collaboration in solid waste research, the exploration of opportunities for partnership, and the integration of efforts across stakeholder groups.

The annual event has been gained support from multiple public and private institutions, growing to become a multi-day conference.

Workshop topics have included:

### Solid Waste Management Partnership Workshop, June 24 2014

- Partnership opportunities by NSERC
- Overview of Solid Waste Management current trends in Europe
- Overview of Solid Waste Management current trends in U.S.A.

**Resource Recovery Partnership Workshop 2015, June 24 2015**

- The State of Waste Research in Canada and How Academia Can Contribute to the Development of Better Public Policy.
- What are the most critical research areas that would benefit municipalities and regulators and how can academia help local and national governments prepare for new and emerging challenges?
- How is industry investing in research and how would a dedicated program of research help meet the evolving needs on industry?

**Resource Recovery Partnership Workshop 2016, June 23 2016**

- Opportunities for Support and Fund Research in the Resource Recovery Sector
- Understanding and Managing Existing Data Valuable for the Resource Recovery Sector
- Identifying New Research and Innovation Within Reduction, Reuse and Recycling

**Resource Recovery Partnership Workshop 2017, June 6 2017**

- Circular Economy and Sustainable Materials Management
- Carbon Capture, Reduction and Preservation
- Moving Forward: How to Advance the Resource Recovery Agenda Towards Acceptance

**Resource Recovery Partnership Workshop 2017, June 21-22 2018**

- Circular economy: is there an integrated approach to sustainable energy and sustainable materials management?
- Competing philosophies of the sustainable economy: is there “one” right answer?
- Waste as feedstocks – technology – end markets: can we close the loop to maximize resource efficiency?
- Exploring the versatility of recovery technologies: we can discover the many hidden methods and sources to achieve sustainable energy.
- Charting the path to a sustainable economy by: identifying the financial, legislative and market challenges, impediments and opportunities for advancing the “4th R”.

Partners:



## Sustainable Development Technology Canada Workshops

### **SDTC Virtual Incubator Workshop (Sep 17, 2014) & SDTC Funding Workshop (March 9, 2015)**

The first two workshops, hosted by WISE in partnership with SDTC, targeted entrepreneurs with early-stage clean technologies who plan on applying to SDTC for funding. They provided prospective applicants with key information and practical guidance to prepare quality funding submissions. The sessions enabled participants to assess the potential fit of their technology with SDTC funds, and to help gain an understanding of the application process and key evaluation criteria.

### **SDTC Workshop, October 28, 2016**

For the third SDTC workshop, a selected group of academic researchers and start-up venture founders presented their ideas, proof of concepts, and technology development proposals with the goal to secure funding for their projects' deployment while building tactics for market penetration strategies in the clean tech sector with like-minded partners.

Presentations included:

- Muaaz Masood: Energy Storage
- Abid Hussain: Energy-Efficient Wastewater Treatment: Partially Mixed Anaerobic Bioreactor
- Zac Young: Harnessing the Power of Nanotechnology in the Energy Sector

- Bijan Mahbaz: Assessment of Concrete Structure
- Joseph Tam & Ahsan ul Alam: Electric Vehicle Charging Infrastructure
- Tom Siu & Jennifer Miller: Renewable Energy
- Hamed Mohammadifardi: Wind Energy
- Sanjeev Bedi: Solar Energy
- Mike Voll: Microgrids

Partners:



SUSTAINABLE DEVELOPMENT  
TECHNOLOGY CANADA  
TECHNOLOGIES DU DÉVELOPPEMENT  
DURABLE CANADA

## AE4H Events

### AE4H Innovation Lab 2017

AE4H hosted a 2.5-day workshop in June 2017, with support from WGSJ, KIT, and the Institute for Advanced Sustainability Studies, focused on bringing together a collection of leading thinkers and innovators from the AE4H consortium to scope new research areas for the network to pursue.



This workshop was attended by an invited group of 53 experts from 31 institutions and 16 different countries, including academic researchers, entrepreneurs, energy policy-makers and civil society leaders.

The AE4H Innovation Lab featured working sessions on a diverse set of themes:

- Scaling micro-grid development

- Capacity-building at the last mile
- Supporting energy access entrepreneurs
- Establishing effective research to impact labs
- Working with local partners: private vs. public
- Inclusive business models for the BOP
- Data, IoT and smart infrastructure deployment
- Global talent pool development and training
- End-uses and users of electricity

Key outcomes from the event included:

- The establishment of a core scientific advisory group for AE4H that will steer the development of future innovation lab events. The group is composed of leading experts from UW, KIT, the University of Oxford, UC Berkeley and Arizona State University.
- A special issue of IEEE Proceedings entitled 'Electricity for All: Solutions for Energy Disadvantaged Communities', with guest editors Prof. Jatin Nathwani (WISE), Prof. Claudio Canizares (WISE) and Prof. Dan Kammen (UC Berkeley).
- A follow-up innovation lab to be held as a side-event at the 'International conference on solar technologies and hybrid mini-grids to improve energy access' in Palma de Mallorca, Spain. The event a partnership between WISE, The Siemens Foundation, Trama TecnoAmbiental (a Spanish off-grid technology consultancy) GIZ (the German International Development Agency), SNV (the Dutch International Development Agency), EnDev (an energy access initiative financed by six donor countries: the Netherlands, Germany, Norway, United Kingdom, Switzerland and Sweden), and REPIC (An interdepartmental platform of the Swiss government for renewable energy promotion). The event will cover a range of topics from policy to finance, advanced technologies, and capacity-building related to energy access initiatives all over the world. Prof. Nathwani and AE4H Manager Nigel Moore are members of the scientific and organizing committees, respectively.
- A WISE report that outlines practical steps for planning, organizing and executing 'innovation labs', which is now available through the University of Waterloo's Office of Research, and distributed to researchers engaged in international partnership building and workshop organization activities.

Two follow-up side innovation lab side events were hosted by WISE at international conferences in 2018:

- Poverty Eradication Through Energy Innovation Workshop (Arizona State University, February 2018)
- International Conference on Solar Technologies and Hybrif Mini-grids to Improve Energy Access (University of the Balleric Islands, October 2018)

Owing to its success, WISE is pusuing the AE4H innovation lab as an annual event. The next AE4H innovation Lab is scheduled to take place in Waterloo in June 2019, and will involve core partners from the University of Oxford, Arizona State University, The University of California, Berkeley, the Massachusetts Institute of Technology, and the Karlsruhe Institute of Technology, along with a number of AE4H members from other collaborating institutions.

Partners:

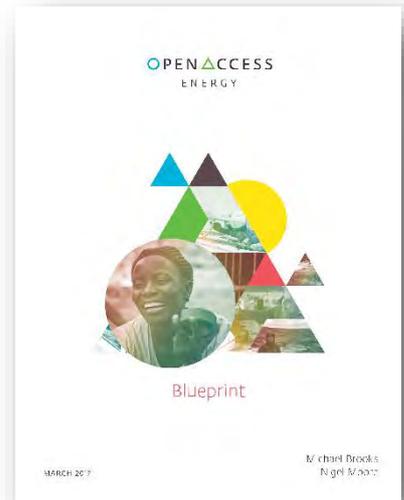


### OpenAccess Energy Summit

The Open Access Energy Summit' was held in April 2016 at the Perimeter Institute for Theoretical Physics in Waterloo. Hosted by the Waterloo Global Science Initiative (WGS|I), in collaboration with WISE Executive Director (WGS|I Scientific Advisor, and WISE Manager Nigel Moore (WGS|I Researcher and Writer), the summit brought together an interdisciplinary and multigenerational group of leading thinkers and practitioners on the topic of global energy access. Globally renowned experts and future leaders from 22 different countries and four of Canada's First Nations participated. Extensive media coverage from TVO's 'The Agenda', The Globe and Mail, and award-winning investigative journalism start-up Discourse Media followed the event.

The outputs of the summit include the 'OpenAccess Energy Blueprint' — an in-depth, solutions-focussed summary of key recommendations from the summit. The Blueprint, co-authored by WISE Manager Nigel Moore, suggests four strategies to create a thriving energy access sector:

1. **Enable** – Establish national energy plans, and a policy and regulatory environment conducive to the creation of off-grid electricity services;
2. **Align** – Facilitate creative alliances between those seeking to provide electricity services and those who can finance the projects;
3. **Empower** – Build the human capacity to allow the sector to thrive – especially drawing on the strength of women and community members to deliver solutions at the 'last mile' through education, training and networking;
4. **Incubate** – Create financially sustainable platforms to help energy entrepreneurs succeed in creating sustainable energy businesses that can serve even the most difficult and impoverished markets.



Partners:



## Other Events

### Geothermal Symposium

This event, hosted by WISE on September 26, 2017, featured distinguished speakers from across the globe in the field of Geothermal Energy.

The Geothermal Symposium consisted of a keynote talk titled 'Put the Planet in Your Portfolio' by Murat Basarir, Manager, Business Development for CoPower, and four panel presentations led by authorities in different areas of the Geothermal Energy sector, including:

- Panel 1 (Academic) – Overcoming R&D challenges for Geothermal Energy: Navigating Convolutions of technical, social, and political Paradigm shifts of the 21st Century
- Panel 2 (International) – Technical and Economic Considerations: An Overview of the Global Market
- Panel 3 (Industry) – The Future of Geothermal Energy in Canada: Technology Roadmap for Geothermal Heat and Power
- Panel 4 (Funding Agencies) – Science, Technology and Innovation Strategies: Management and Mobilization of Financial Resources for Geothermal Technology Development

### Waterloo Regional Decarbonization Forum

On November 17th-18th, 2016 Professor Heather Douglas, Waterloo Chair in Science and Society and WISE Associate Director, launched the Decarbonization Forum: Charting Waterloo's Energy Future, with the aim to envision a carbon free Waterloo Region by the year 2050.

This two-day forum brought together 50 academic, government, industry, and local NGO stakeholders from the Waterloo region to develop a holistic, long-term view of our energy system and identify decarbonization challenges.

The major challenges identified include:

1. Dramatically reducing energy needs of the build environment
2. Maximize local renewable power generation
3. Eliminating fossil fuels based transportation
4. Replacing natural gas as a source of energy for heating

Partners:



### **Green Growth, Sustainable Communities and the Circular Economy International Workshop**

This event hosted by WISE at the University of Waterloo on May 29, 2017 was the second in a series, following a meeting at Dalian University of Technology in 2015, as part of an international collaboration between Dalian University of Technology in China, the University of Waterloo in Canada, Imperial College London in the UK and the International Academy of Ecology and Life Protection Science in Russia.

The collaboration explores strategies for green growth through providing a platform for researchers from the four institutions to share case studies that illustrate widely applicable strategies to simultaneously achieve economic and environmental stewardship aims.

The event featured a keynote talk titled 'Sustainability as a Source of Innovation for New Growth' by Richard Blundell from the University of Toronto, and panel presentations and discussions on three topics:

- Business Strategies for green growth
- Cities, Infrastructure and Planning for Sustainability
- The Circular Economy

Partners:



**Imperial College  
London**



## Green House Gas Emissions Workshop

On October 12, 2016, WISE hosted a public event to share Waterloo's research expertise on technologies that are revolutionizing the development of greenhouse gas reduction, including innovative solutions for a variety of industrial sectors. An overview of potential funding opportunities through Ontario Centres of Excellence and NSERC was also presented, to aid researchers in securing further funding for their work.

This event focused on the following domains of research exploration:

- Industrial Point Source emissions
- Emissions Throughout the Value Chain
- CO2 Capture, Storage and Utilization Innovations

Partners:



## 3.3.2 Public Lecture Series

Since 2013, WISE has hosted 65 lectures that have brought sustainable energy leaders from all over the world to the University of Waterloo. These lectures, which are open to the public, help bring the insights and latest developments in the field to the Waterloo community, allowing our professors, students, and other stakeholders to engage with leading researchers, industry experts, and government officials.

### 2013

*PEM Fuel Cell Catalysis and Supercapacitors at National Research Council of Canada*  
Dr. Jiujun Zhang, Principle Research Officer, National Research Council Canada, Vancouver, BC  
May 23, 2013

*CO2 Storage at the Ketzin Pilot Site, Germany: 5th Year of Injection, Multidisciplinary Monitoring and Modelling*  
Dr. Sonja Martens, Project Manager Ketzin, Centre for Geological Storage, GFZ German Research Centre for Geosciences, Postdam  
May 31, 2013

*The Role of Hydro in Modern Sustainable Power Grids*  
Phil Helwig, M.Sc., P. Eng., Hydropower Consultant, Helwig Hydrotechnique Limited  
July 12, 2013

*Understanding Active Network Management in 40 Minutes*  
Prof. Damien Ernst, Associate Professor, University of Liège  
August 9, 2013

*Energy Perspectives for Germany and Europe: A Researcher's View*  
Dr.-Ing. Joachim U. Knebel, Chief Science Officer, Karlsruhe Institute of Technology (KIT), Germany  
October 2, 2013

*Behaviour Change: An Untapped Resource in Coping with Climate Change*  
Dr. Ron Dembo, Founder and CEO of Zerofootprint, Founder and former CEO of Algorithmics  
October 29, 2013

### 2014

*Canadian Responsibility and the Energy Trilemma*  
Dr. Brenda Kenny, President & CEO, Canadian Energy Pipeline Association (CEPA)  
February 12, 2014

*Microalgae for Energy Production: Between Dream and Reality*  
Dr. Eric Prouzet, Associate Professor, Chemistry at the University of Waterloo & Co-Founder of Prodal-G Inc.  
May 22, 2014

*The Ecological Hoofprint: Meat, Energy, and Sustainability*

Tony Weis, Associate Professor, Geography at the University of Western Ontario  
October 15, 2014

*Transformations across the Energy Sector: Past, Present and Future*

Graham Campbell, President, Energy Council of Canada  
November 5, 2014

**2015**

*Demand and Response and Capacity Auctions for Ontario*

Tom Chapman, Markets Group, Independent Electricity System Operator  
February 10, 2015

*Modeling Multi-Scale Processes in Hydraulic Fracture Propagation Using the Implicit Level Set Algorithm (ILSA)*

Dr. Anthony Pierce, Professor, Department of Mathematics, The University of British Columbia  
March 26, 2015

*A Practical Framework for the Implementation of the Vehicle-to-Grid (V2G) Concept*

Professor George Gross, Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign  
April 17, 2015

*Synthesis of Coal-Based Clean Fuels and Chemicals*

Professor Zhong Li, Deputy Director, Key Lab of Coal Science & Technology, Taiyuan University of Technology  
June 12, 2015

*Microgrid Analysis, Optimization & Implementation*

Dr. Bala Venkatesh, Lecturer, Dept. of Electrical and Computer Engineering and Academic Director, Center of Urban Energy, Ryerson University  
September 30, 2015

*Sustainability and Geothermal Energy Studies in Geotechnical Engineering*

Dr. Anand Puppala, University of Texas at Arlington  
October 9, 2015

*The Impact of “Energiewende” on Renewable Energies in Germany*

Dr. Alexandra Pehlken, Lecturer in Bioenergy for the International PPRE Program, Oldenburg University, Germany  
October 22, 2015

*Design of a Participatory-Model Microgrid/Smart-Farm System for the Mapuche Indigenous Communities*

Dr. Doris Sáez Hueichapan, Associate Professor, Dept. of Electrical Engineering, Universidad de Chile  
November 17, 2015

**2016**

*Electric Vehicle (EV) Charging*

Klaus Dohring, President, Green Sun Rising Inc.  
February 4, 2016

*Insights and Considerations for PEX Energy and Plumbing Applications*

Teresa Jiang, Business Development Manager — Central Canada, Uponor Ltd.  
April 12, 2016

*Forensic Energy Management*

B. Paul Mertes, President and CEO, CircuitMeter Inc.  
May 3, 2016

*Forest Bioenergy in Ontario: Examining the Life Cycle Impacts and Costs of Using Harvest Residue as Feedstock for Small- and Large-Scale Bioenergy Systems*

Dr. Julian Cleary, Expert in Environmental Life Cycle Assessment  
June 28, 2016

*Helical Piling Applications in Canada*

Jeff Lloyd, President, Almita Piling  
July 22, 2016

*Natural Ventilation of Buildings Using a New Design of Wind-Catcher to Decrease Energy Consumption in Windy Regions*

Dr. Madjid Soltani, Director, HVAC & Energy Lab, K.N.Toosi University of Technology  
August 4, 2016

*Wind Turbine Aerodynamics and Solar Car Cooling Systems*

Dr. Kobra Gharali, Assistant Professor, Mechanical Engineering, University of Tehran, Iran  
August 16, 2016

*How Can We Help Electricity Access Scale-up Faster?*

Dr. Claudio Vergara, Postdoctoral Associate, MIT Tata Center for Technology and Design  
September 26, 2016

*Demand-Side Management, Micro-Grids, Demand Response and Reducing the Need to Overbuild Capacity*

Paul M. Grod, President & CEO, Rodan Energy Solutions  
November 22, 2016

*Natural Gas – an Important Transportation Fuel as Part of a Low Emission Logistics Strategy*

Tariq Qurashi, NGT Sales Consultant, Enbridge Gas Distribution Inc.  
November 29, 2016

*Experimental and Computational Optimization of a Wind Turbine Blade De-Icing System*

Daniela Roeper, Founder, Borealis Wind  
December 13, 2016

*Energy Economics – Towards Sustainable Development & a ‘Green GDP’*

Sankaran Ramalingam, President, Energy and Fuel Users Association of India (ENFUSE)

December 15, 2016

**2017**

*Electricity, an Industry in Transition*

Benjamin Grunfeld, Managing Director, Navigant

January 25, 2017

*Solar + Storage + IOT + LED = \$30 Trillion*

Dr. Srinivasan Keshav, Professor, Cheriton School of Computer Science, UW

February 13, 2017

*Piezoelectric Materials and Their Applications*

S. Eswar Prasad, Chairman, Piemades, Inc. and Adjunct Professor, Dept. of Mechanical and Industrial Engineering, University of Toronto

April 18, 2017

*Energy-Secure, Adaptable Housing and Infrastructure for Remote and Northern Communities*

Peter Russell, President, RESTCo

April 19, 2017

*Post-Net Metering for a Sustainable City*

Dr. Matthew Peloso, CEO and Founder of Sun Electric Pte. Ltd., Singapore

May 19, 2017

*Smarter Cities: New Services, New Applications for Control*

Dr. Robert Shorten, Chair, Control Engineering & Decisions Science, University College, Dublin

June 26, 2017

*Printed MEMS: sensors, actuators or energy harvesters processing with standard or modified screen-printing*

Hélène Debéda, Associate Professor, University of Bordeaux, IMS Laboratory, PRIMIS team

June 28, 2017

*Hydraulic Fracture Field Experiments for Geothermal Energy*

Dr. Mohammad Reza Jalali, Lecturer & Researcher, Swiss Federal Institute of Technology (ETH)

July 5, 2017

*Directional Drilling and Magnetic Ranging Services for Geothermal Energy Development*

Clinton Moss, President, Marksman Ranging Technologies, Scientific Drilling

July 5, 2017

*Self-Dependency in Remote Communities: Food, Energy, Future*

Benjamin Canning, Co-Founder & Co-Project Manager, Growing North  
As presented by Monica Khaper, Director, Sustainability, Growing North  
July 11, 2017

*Physics-based Control of Energy Systems Ranging from Smart Buildings and Power Grid to Smart Hybrid Electric Vehicles*

Mahdi Shahbakhti, Associate Professor, Mechanical Engineering – Engineering Mechanics, Michigan Tech  
August 2, 2017

*Navigating Ontario's Evolving Energy Landscape – A Utility's Experience*

Nirupa Balendran, Conservation Energy Manager, Newmarket-Tay Power Distribution Inc.  
September 11, 2017

*Ontario's Emissions and Long-Term Energy Planning*

Marc Brouillette, Principal Consultant, Strategic Policy Economics  
October 24, 2017

*Greenhouse Gas Reduction Technologies in Energy Intensive Sectors of Ontario*

Martin Vroegh, Senior Director, Greenhouse Gas Reduction Technologies, Ontario Centres of Excellence  
October 26, 2017

*Changing Perspectives in Ontario's Electricity Industry*

Erik Veneman, Vice President, Innovation and Growth, Guelph Hydro Electric Systems Inc.  
November 21, 2017

**2018**

*Energy: Ten BIG Ideas on Energy (What Everyone Needs to Know)*

Adonis Yatchew, Professor, Economics, University of Toronto  
January 25, 2018

*The Future of New Zero Homes in Canada*

Mehmet Ferdiner, Manager, energy Modelling Services, Building Knowledge Canada  
February 13, 2018

*Reducing Carbon Emissions Through Energy Efficiency: A Canadian Perspective*

Chandra Ramadurai, CEO, Efficiency Capital  
February 22, 2018

*OTSG in Power Generation and Energy in Canada*

Alex Berruti, Senior Product Engineer, Enhanced Oil Recovery for Innovative Steam Technologies (IST)  
April 24, 2018

*Actualizing Smart Infrastructure to Enable Data-Driven Asset Maintenance Decisions*

Dr. Sriram Narasimhan, Canada Research Chair, Smart Infrastructure; Associate Professor, Civil and Environmental Engineering & Mechanical and Mechatronics Engineering (cross-appointed), University of Waterloo  
June 15, 2018

*Health Impacts of Climate Change and Climate Policy*

Dr. Rebecca K Saari, Assistant Professor, Civil and Environmental Engineering, University of Waterloo  
June 26, 2018

*Decoding the Energy Access Puzzle: An Overview of an Experiment at the Grassroots Level*

Sankaran Ramalingam, Founding Director, Fuel-Users Association of India  
July 13, 2018

*Biogas – Resource Recovery and Clean Tech*

David Thompson, Project Manager, Technical Services, Walker Environmental  
July 24, 2018

*Csan Building Science Save the Day?*

Jaan Timusk, Professor Emeritus, Civil Engineering, University of Toronto  
August 14, 2018

*The New Fast.Farm: Wind Farm Design and Analysis*

Dr. Jason Jonkman, Senior Engineer, NREL  
September 20, 2018

*Blockchain: A New Foundation for Distributed Energy Resources?*

Vikram Singh, Director of Advanced Planning, Alectra Utilities  
September 28, 2018

*Show Me Your Forecasts, I'll Show You Mine! Are we moving towards energy data markets?*

Pierre Pinson, Professor, Centre for Electric Power and Energy, Electrical Engineering, Technical University of Denmark  
October 10, 2018

*The Aesthetics of Renewable Energy: Designing a Post Carbon Culture*

Elizabeth Monoian and Robert Ferry, Co-founders, Land Art Generator Initiative  
November 8, 2018

### 3.3.3 Media Exposure

Over the past five years, WISE, particularly through Executive Director Jatin Nathwani, has engaged with a variety of national and international media outlets — print, online and broadcast – to tell the story of the sustainable energy revolution and the cutting edge role of Waterloo research. This coverage reflects a growing recognition of WISE and its members as thought leaders and cornerstones of the Canadian sustainable energy research landscape. WISE members comprise an independent but authoritative source of commentary and analysis of energy issues, many of which are highlighted in the coverage below:

#### Television

CTV News Kitchener

Local News Interview

*'Electric vehicle conference brings together researchers and owners', Prof. Nathwani.*

May 2, 2018

The Agenda with Steve Paikin

National TV Panel Discussion

*'Our Nuclear Future', Prof. Nathwani*

October 20, 2016

The Agenda with Steve Paikin

Episodes of TV Ontario's The Agenda program from the OpenAccess Energy Summit

*'An Energy Revolution' Prof. Nathwani*

April 26, 2016

The Agenda with Steve Paikin

Episodes of TV Ontario's The Agenda program from the OpenAccess Energy Summit

*'Ending Energy Poverty', Prof. Nathwani*

April 25, 2016

The Agenda with Steve Paikin

Ontario's Overpriced Electricity

*'Are Ontarians paying too much for electricity?', Prof. Nathwani'*

November 26, 2013

**Print & Online**

Policy Options

*'Raise the GST as part of pragmatic plan for climate action', Prof Nathwani*

October 17 2018

The Labradorian

*'Sustainable energy assessment under way in southern Inuit communities', Prof Canizares*

Jul 16, 2018

TVO Current Affairs

*'The good, the bad, and the ugly: A look back at 15 years of Liberal government', Prof Nathwani*

Jun 15, 2018

The Toronto Star

*'Hydro rates should be subsidized. Borrowing now ensures future capacity.' Prof Nathwani*

May 15, 2018

Science Trends

*'A Regional Energy Hub For A Global Transition To A Low-Carbon Economy', Prof Nathwani*

May 15, 2018

The Globe and Mail

*'Ontario Auditor-General Bonnie Lysyk does disservice to public by getting it wrong on hydro costs' Prof Nathwani*

May 6, 2018

TVO Current Affairs

*Why power-hungry Ontarians need to take a new approach to technology, Prof Nathwani*

May 2 2018

iPolitics

*'Putting Humpty Dumpty back together again: Ontario NDP's hydro plan leaves experts cold,' Prof Nathwani*

Apr 27, 2018

The Record

*'UW charges ahead with electric vehicle research', Prof Nathwani*

Apr 26, 2018

Globe and Mail

*'Pipeline rhetoric and reality: It's time for an adult conversation', Prof Nathwani*

February 9, 2018

The Conversation

*'Empowering the powerless: Let's end energy poverty', Prof Nathwani*

Jan 29, 2018

Harrowsmith Magazine

*'Energy Poverty in Indigenous Communities – Confronting a national shame', Nigel Moore*

January 1, 2018

The Conversation (reprinted in the National Post)

*'Clean Energy Can Advance Indigenous Reconciliation', Prof. Nathwani*

October 26, 2017

The Conversation (reprinted in the Energy Post)

*'Solar Alone won't solve energy or climate needs,' Prof Nathwani*

Sept 25, 2017

TVO Current Affairs

*'What the Lake Erie Connector project could mean for your hydro bill,' Prof. Nathwani'*

June 30, 2017

Globe and Mail

*'Climate Strategies – Tango Between Climate Change and Energy Policy', Prof Nathwani*

April 22, 2017

The Hill (US)

*'Renewables Are Not Equally Green' D Lam and Prof Nathwani,*

March 7, 2017

TVO Current Affairs

*'Outrage not justified on Ontario electricity prices,' Prof Nathwani'*

March 6, 2017

The Hill (US)

*'Trump unlikely to approve Keystone XL pipeline quickly', D. Lam, Prof Nathwani*

Jan 9, 2017

TVO Current Affairs

*'How Ontarians can take power back from big energy plants,' Prof Nathwani*

Sept. 22, 2016

CBC News

*'Wind, solar energy real options for Canada's remote Arctic communities' Prof*

*Canizares*

Sept 17, 2016

WWF Online

*'Renewable energy financially feasible in Nunavut, study shows' Prof Canizares*

May 31, 2016

Globe and Mail

*'Indigenous communities must be part of the global green energy revolution,' Prof Nathwani*

April 27, 2016

TVO Current Affairs

*'Could nuclear energy be Ontario's trump card?' Prof Nathwani*

Dec. 16, 2015

Globe and Mail

*'Auditor General offers incomplete picture of Ontario's power upgrade', Prof Nathwani*

Dec. 10, 2015

Maclean's

*'The hard truths behind Ontario's pricey electrical system' Prof Nathwani*

Dec 10, 2015.

TVO Current Affairs

*'Does Ontario's Bruce nuclear deal make financial sense?' Prof Nathwani*

Dec. 7, 2015

Globe and Mail

*'Drafting a new architecture for energy', Prof Nathwani, Report on Business Weekend*

Nov 28, 2015

TVO Current Affairs

*'What Ontarians don't know about rising hydro rates', Prof Nathwani*

Nov. 6, 2015

SmartGrid Today

*'Canadian Solar executive details buildup of microgrids'*

Jan 15, 2015

Toronto Star Canada Day National Supplement

*'Canada Driving a global energy transition' Prof Nathwani*

June 30, 2014

Globe and Mail

*'Sustainable Energy Supplement' Prof Nathwani*

May 21, 2014

Bloomberg BNA, International Environment Reporter

*'Technical, Economic and Political Hurdles Hamper Renewable Energy Future' Prof Nathwani*

March 27, 2014

Toronto Star

*'Degrading condo windows expected to trigger major wave of replacements' Prof.*

*Straube*

Feb 19, 2014

The Globe and Mail

*'Can wind power cut northern dependence on diesel?' Prof Canizares*

Dec 3 2013

The Globe and Mail

*'If nothing else, green power has to be green' Prof. Nathwani*

Dec 9, 2013

The Globe and Mail.

*'Major investments needed for Canada to achieve full electricity security', Prof Nathwani*

Nov 12, 2013

Toronto Star Media Planet

*'Ask the Experts: "The future of research and development in sustainable energy." Prof*

*Nathwani*

Nov 28, 2013

Engineering Dimensions

*'Ontario's Energy Policy: Looking Beyond Ontario' Prof Nathwani*

August 2013

Policy Options

*'Beyond Keystone: Canada's Clean Electricity' Prof Nathwani*

June 2013

### 3.3.4 Selected WISE Member Publications

#### 2013

O. Ardakanian, **C. Rosenberg**, and **S. Keshav**, “Distributed Control of Electric Vehicle Charging”, Proc. ACM e-Energy 2013, May 2013. **(Winner of Best Paper award)**

**I. H. Rowlands**, “Smart Energy Networks: The 2013 Leadership Event and Beyond” (Waterloo, ON: Waterloo Institute for Sustainable Energy, SEN Working Paper # 3, November 2013), 30pp.

**O. Weber** (2013). “Social Banks and their Profitability: Is Social Banking in line with Business Success?” In L. San-Jose & J. L. Retolaza (Eds.), *Prospective Innovation at Ethical Banking and Finance* (pp. 2-19).

M. Arriaga, **C. Canizares** and M. Kazerani, “Renewable Energy Alternatives for Remote Communities in Northern Ontario, Canada”, in the *IEEE Transactions on Sustainable Energy*, Vol. 4, Issue 3, July 2013, pp. 661-670.

S. Zendejboudi, A. Shafiei, A. Bahadori, **Y. Leonenko**, I. Chatzis (2013), “Droplets evolution during ex situ dissolution technique for geological CO<sub>2</sub> sequestration: Experimental and mathematical modelling”, *International Journal of Greenhouse Gas Control*, 13, 201–214.

**J. Nathwani**, Z. Chen, M. P. Case, Z. A. Collier, P. E. Roege, S. Thorne, W. Goldsmith, K. V. Ragnarsdottir, P. M. Marks, M. Ogrodowski (2013). “Sustainable Energy Pathways for Smart Urbanization and Off Grid Access: Options and Policies for Military Installations and Remote Communities” in I. Linkov, (Ed.), *NATO Science for Peace and Security Series C, Environmental Security*, Linkov, Igor (Ed), Springer Verlag, 2014 XVI, 400p, ISBN 978-94-007-160-4

#### 2014

O. Yuksel Orhan, G. İ̇s, E. Alper, K. McApline, S. Daly, M. Sycz, and **A. Elkamel**, “Gasification of Oil Refinery Waste for Power and Hydrogen Production”, *Proceedings of the 4<sup>th</sup> International Conference on Industrial Engineering and Operations Management (IEOM 2014)*, paper # 314, pages 1-10, Bali, Indonesia, January 7-9, (2014). **(Awarded the Best IEOM 2014 Track Paper in Technology Management)**.

I. Linkov, T. Bridges, F. Creutzig, J. Decker, C. Fox-Lent, W. Kröger, J. H. Lambert, A. Levermann, B. Montreuil, **Jatin Nathwani**, R. Nyer, O. Renn, B. Scharte, A. Scheffler, M. Schreurs, T. Thiel-Clemen (2014) “Changing the resilience paradigm” *Nature Climate Change*

C. Hoicka, **P. Parker**, J. Andrey (2014). “Residential energy efficiency retrofits: How program design affects participation and outcomes”. *Energy Policy* 65 (0) (Feb.): 594–607. doi: 10.1016/j.enpol.2013.10.053.

Arriaga, M., **Canizares, C., & Kazerani, M.** (2014). Northern Lights: Access to electricity in Canada's northern and remote communities. *IEEE Power and Energy Magazine*, 12(4), 50 – 59.

Sanscartier, D., **Dias, G.**, Deen, B., Dadfar, H., McDonald, I., & Maclean, H. (2014). Life cycle greenhouse gas emissions of electricity generation from corn cobs in Ontario, Canada. *Biofuels Bioproduction and Biorefining*, 8(4), 568 – 578.

Mohanto, S., Singh, K., Chakraborty, T., & **Basu, D.** (2014). Cyclic thermo-mechanical analysis of wellbore in underground compressed air energy storage cavern. *Geotechnical and Geological Engineering*, 32(3), 601 – 616.

Ibrahim, M., & **Salehian, A.** (2014). Modeling, fabrication, and experimental validation of hybrid piezo-magnetostrictive and piezomagnetic energy harvesting units. *Journal of Intelligent Material Systems and Structures*, 26(10), 1259 – 1271.

## 2015

**Bhattacharya, K.**, Sharma, I., & **Cañizares, C.** (2015). Smart distribution system operations with price-responsive and controllable loads. *IEEE Transactions on Smart Grid*, 6(2), 795 – 807.

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Olivares, D., Lara, J., **Cañizares, C., & Kazerani, M.** Stochastic-Predictive energy management system for isolated microgrids. (2015). *IEEE Transactions on Smart Grid*, 6(6), 2681 – 2693.

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Koksal, M., **Rowlands, I., Parker, P.** (2015). Energy, cost, and emission end-use profiles of homes: An Ontario (Canada) case study. *Applied Energy*, 142, 303 – 316.

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**2016**

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Salkuyeh, Y.K., **Elkamel, A.**, Thé, J., & **Fowler, M.** (2016). Development and techno-economic analysis of an integrated petroleum coke, biomass, and natural gas polygeneration process. *Energy*, 113, 861-874.

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Karanasios, K., & **Parker, P.** (2016). Recent Developments in Renewable Energy in Remote Aboriginal Communities, Quebec, Canada. *Papers in Canadian Economic Development*, 16, 98-108.

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**Simpson-Porco, J. W.**, Dörfler, F., & Bullo, F. (2017). Voltage stabilization in microgrids via quadratic droop control. *IEEE Transactions on Automatic Control*, 62(3), 1239-1253.

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## **4. FUTURE DIRECTIONS**

# 4. Future Directions

## 4.1 CONTEXT

Since its founding in 2008, WISE has initiated projects across a wide range of knowledge domains encompassing sustainable energy development. From developing funding for new high-tech labs to support emerging disciplinary research clusters, to bringing together researchers, policy-makers and industry leaders in dialogues around the future of the clean energy sector in Ontario and beyond, WISE has pursued opportunities both opportunistically and with the long-term in mind.

As we look forward to our next five years, WISE has identified opportunities across four themes where our expertise, connections and resources align with a vision of global leadership. Not only are these areas of great interest to our members and partners, they also reflect increasingly vital elements of the sustainable energy transition at the local and global level. At WISE, we see this transition broadly following 5 macro-trends: **decarbonization**, **decentralization**, **digitization**, **deregulation** and **democratization**.

Rapid **decarbonization** of energy systems must be a central part of climate change action, as the energy sector represents a major source of greenhouse gas emissions globally. It has become increasingly clear however that the trend toward decarbonization of energy systems will continue irrespective of climate policy. The cost of renewable energy systems is falling fast, and they have other benefits including modularity and scalability. The past half decade has shown that stakeholders ranging from individual consumers to large industries have increasingly adopted clean technology.

The move towards renewable generation from sources available almost anywhere such as solar and wind makes **decentralization** of the power grid possible. This shift offers consumers more choice in the technologies and policies that govern energy generation and use, as well as the ability to participate more actively in the energy system as a 'prosumer' – a new kind of energy system stakeholder that is both a consumer and producer of energy. It also enhances grid resilience to external shocks such as natural disasters or cyber attacks.

In a future where many different sources and technologies are embedded within a highly complex decentralized energy system, **digitization** will become the cornerstone of a well-functioning, efficient grid. Through advanced information and communications technologies, as well as the extensive use of data to drive decision-making and enhance the intelligence of stakeholders and systems, the energy system of the future can become self-organizing: efficient markets, self-healing grids, and improved resilience.

As the energy system changes, **deregulation** has become at trend that allows the new paradigm to emerge organically and efficiently. Our regulatory structures were built for the old, centralized energy system. As the new system emerges, deregulation will allow new innovations to enter the market successfully, creating new economic value.

The confluence of these four trends should result in a fifth: **democratization** of the energy sector. This powerful force has the potential to create more transparency in energy systems, more consumer choice, and genuine opportunities for smaller stakeholder groups, including individuals, to participate meaningfully in the energy system and to extract and contribute value as a result of this participation.

## 4.2 PRIORITY AREAS

### 4.2.1 Smart Energy Infrastructure

The smart, sustainable energy systems of the future will require efficient integration of a variety of energy generation, transmission and end use technologies. From electric vehicles, to smart grids, energy storage and buildings that both produce and consume clean energy, this smart energy infrastructure must be efficiently networked to ensure the best use of variable sustainable energy resources.

Waterloo, as an established leader in cutting edge information and communications technologies (ICT), has an important role to play in developing new ideas and technologies that will enable a 'whole-systems' approach to smart energy infrastructure integration. WISE therefore aims to cement the leadership position of UW as a place for innovation on the convergence of sustainable energy technology and data-driven ICT-enabled solutions.

This approach is critical in any environment where clean technology will not only be deployed on a large scale but can become a basis for export-led economic growth in Canada. Increasingly, WISE realizes the vital role of efficient energy use in regions facing energy insecurity. As remote communities in Canada and abroad grapple with the opportunities and challenges of investing in cleantech, WISE will endeavor to work alongside them in developing smart energy solutions that allow them to maximise the benefits of limited resources. WISE believes that smart energy infrastructure is not a luxury but rather a critical component of any cost-effective clean energy system, irrespective of its location.

#### WISE Objectives:

- 1) **Collaborate** with UW faculty whose work is at the interface of ICT, data science and energy systems by providing assistance in identifying funds to support their work, and establish strong networks with industry so that UW innovations can find real-world applications.
- 2) **Reach Out** to communities, governments, and other stakeholders to develop innovative, end-user driven action research projects that test and deploy smart energy solutions in communities where they will improve energy service quality and reduce overall system costs, with particular focus on regions facing energy insecurity.
- 3) **Influence** and prioritize the emergence of data-driven solutions to energy sector challenges in the areas of electric mobility, energy market design, energy transactions and finance, energy system planning, and efficient buildings.

## 4.2.2 Inclusive Global Energy Transformation

The transformation of energy systems towards integration of sustainable energy infrastructure, new business models for energy delivery, and incentives around energy use, requires decisive policy action. Decisions made by powerful public and private sector actors should be inclusive of the desires, ability to pay, habits and priorities of consumers, as well as being resilient to future challenges posed by the need for climate adaptation.

UW-based experts from the social sciences, including economics, law, policy and environment can play an important role in guiding sustainable energy transitions with such complexities in mind. WISE aims to muster this expertise to help ensure that new technologies and socio-economic systems of energy delivery are fair, attuned to the needs of diverse stakeholders, and show a high degree of resilience against unpredictable threats.

Issues such as divestment from fossil fuels, stranded fossil fuel assets, conservation initiatives, and choices between sustainable energy generation, transmission and storage technology suites have far-ranging implications for Canada's economy. These are areas with questions that cannot be answered solely by experts, requiring inclusive dialogue. WISE aims to use our position to help broker potential social conflicts around energy transformation and thereby support multi-level energy sector planning in Canada.

### WISE Objectives:

- 1) **Collaborate** with faculty members from the social sciences, particularly within the Faculty of Environment and the School of Accounting, on issues such as divestment, stranded assets, conservation, and energy infrastructure investment, which are of acute interest to Canadian energy policy-makers and major industry players.
- 2) **Reach Out** to a range of stakeholders, including citizen-driven grassroots organizations to understand concerns about energy sector transformation and host events that cover key topics of interest and bring stakeholders together for constructive and inclusive dialogue.
- 3) **Influence** political and industry decision-making related to energy systems planning in Canada by leveraging our connections with the Canadian policy community and energy industry. Deliver insights that support decision-making that is aligned with pressing concerns of citizens.

## 4.2.3 Affordable Energy for Humanity

Over one billion people on the planet do not have access to electricity, and over a billion more have unreliable access. The challenge of providing energy that is both affordable and clean to a third of humanity is vital to meeting the climate change and sustainable development challenges of the 21<sup>st</sup> century. New cleantech solutions, including those developed at UW, must be brought to bear at a global level in accordance with the urgency of these issues.

WISE has therefore established a new flagship program, the Affordable Energy for Humanity Global Change Initiative (AE4H), which establishes UW as the central node of a globally networked research and action partnership comprised of over 140 global experts from 50+ institutions in 20+ countries. We have identified two core areas of impact: use-inspired design of cutting edge solutions that lower the cost of clean energy for those living at the economic margins, and building human capital for the emerging energy access sector. Through AE4H, WISE is currently advancing a number of initiatives that combine these areas of impact. This includes an active, externally funded global internship program for UW students and a proposal in development which would establish clean energy innovation incubation centres across the developing world.

Acknowledging UW's position as an established global leader in STEM education, we also see an opportunity to broaden the innovation narrative at this institution. Through AE4H, WISE will provide pathways for technologically and entrepreneurially inclined UW community members to participate in the sustainable development revolution, both in the energy sector (UN Sustainable Development Goal 7) and in areas linked to energy (across the rest of the SDGs).

### WISE Objectives:

- 1) **Collaborate** with AE4H partners to identify and pursue research funding opportunities across four domains: generation, devices and advanced materials; micro-grids for dispersed power; ICT for energy sector convergence; and environmental and human dimensions of energy sector transformation.
- 2) **Reach Out** to better understand the challenges and opportunities facing entrepreneurs, civil society organizations and policy-makers committed to clean energy for all. Establish an annual 'Innovation Lab' event in Waterloo that brings these stakeholders together, establishing UW at the centre of global-level dialogue.
- 3) **Influence** the emergence of future entrepreneurial leaders for global energy access by executing a new funded program that places UW students in international social enterprises in the energy sector. Offer excellent networking, leadership and social enterprise support activities on campus to create a vibrant community of UW-based international change-makers.

## 4.2.4 Geothermal Energy

Geothermal energy, sourced from warm, stable temperatures either near the land surface or from deep below, can be used to provide both emissions-free heat and power. While utilized in a variety of regions globally, geothermal energy research and deployment in Canada is sparse. WISE therefore sees a major opportunity to investigate this under-explored energy technology, and to position UW as a leader.

The utilization of geothermal energy to provide heat is particularly valuable in Canada where cold temperatures make alternatives to fossil fuels of great importance. Geothermal energy technologies, like other sustainable energy options, must also be analysed in the context of a wider suite of energy options, as one component of a smart and efficient energy system. Due to its under-explored nature and multiple uses, WISE sees a research gap in this area that is worth exploring.

WISE has recently undertaken a series of activities including joint funding proposals led by UW faculty experts and hosting a geothermal symposium that brought together the major Canadian stakeholders from the geothermal industry and research community. Moving forward, WISE will take advantage of our existing expertise, connections, and emerging leadership position to establish UW as a recognized hub of research on geothermal energy. This will include establishing pilot projects that advance understanding and de-risk the technology, particularly in the Canadian context.

### WISE Objectives:

- 1) **Collaborate** with leading experts at UW, in Canada and abroad to place UW geothermal expertise at the epicentre of cutting edge research on the topic.
- 2) **Reach Out** to industry and other potential sources of funding to establish a geothermal energy laboratory in Waterloo that provides our experts with the tools necessary to advance knowledge in a meaningful way.
- 3) **Influence** policy-makers at all levels of government in Canada to take seriously the real-world potential of geothermal energy production. Clearly communicate uncertainties and gaps in knowledge so that long-term energy planning processes and energy infrastructure and research investments are made wisely.

## 4.2.5 Interdisciplinary Energy Research

In light of the five global mega trends in the energy sector – decarbonisation, digitilaztion, decentarlization, deregulation and democratization – the complexity implicit in the evolution of global and national energy systems puts an enormous premium on effective collaboration across disciplines. Beyond the technological dimensions of the energy system, there is strong need to integrate the perspectives of social sciences and the humanities that would include anthropology, psychology, economics and finance, political science, ethics, philosophy and historical perspectives on energy transitions. The goal is to shape the texture of societal decisions and how inclusive and effective we are in addresssing the future challenges that meet the needs of every global citizen,

WISE acknowledges a gap in the University of Waterloo’s current approach to energy research, which is stongest in the natural sciences and engineering but lacks in the social sciences and humanities. In order to address this, WISE proposes to develop an Interdisciplinary Energy Research Visiting Fellows program. Through this program WISE will host 4-6 energy sector thought leaders from the social sciences and humanities, as well as the energy policy arena, for 3-4 month stays at Waterloo. Visiting fellows will collaborate with WISE faculty members and the WISE staff to advance a specific project that aims to create convergence in a critical area of energy policy debate that affects many stakeholders. The original content that this program generates will greatly expand the influence of WISE in nationl and global level energy policy debates.

To accomplish this objective, WISE is proposing an additional annual budget request of \$80K for the Interdisciplinary Energy Research Visiting Fellows Program. A detailed breakdown and rationale is included in Section 5: Financial Summary.

### WISE Objectives:

- 1) **Collaborate** with UW faculty members from the social sciences and humanities to advance thought-provoking ideas related to the five D’s of energy sector change: decarbonisation, digitilaztion, decentarlization, deregulation and democratization.
- 2) **Reach out** to leading energy scholars and bring them to Waterloo to advance specific, timely projects that generate convergence and enhance interdisciplinarity both within the Waterloo energy innovatration ecosystem and in wider energy policy debates.
- 3) **Influence** critical energy policy debates in Canada and globally (pipelines, stranded assets, subsidies, infrastructure investments, carbon pricing, etc.) through publication of an influential WISE working paper series and other avenues of dissemination of the outputs of the visiting fellows.

# 5. FINANCIAL SUMMARY

## 5.1 Financial Summary

Currently, WISE is supported by the Provost's Office and in conformance with Policy 44 requirements, the WISE Executive Director reports to the Office of Research, VP Research. This is an operational budget that supports, primarily, the salaries of Institute Staff. The detailed breakdown of the Salary and the Operational expenses of the Institute for the period 2013-2018 are shown in Table 5.1.

In addition, WISE manages and administers funding from external organizations and partner organizations to support specific research programs and initiatives, Fellowships (for example the Energy Council of Canada) and internships for graduate and undergraduate students (i.e. the Queen Elizabeth Scholarship program). WISE Administrative activities include responses to calls for applications, selection and approval of research topics and proposals, financial and annual reporting, organizing and hosting visits and chairing meetings, and relationship management with partners. WISE and its members have been highly successful in leveraging industry funds through granting organizations, namely NSERC, NRCan, OCE, MITACS and others.

Over the past 10 years, including Fiscal years 2013-2019, WISE has managed its activities and programs within budget – without deficits – for every year since its founding in 2008.

Please refer to the Table 5.2 for a summary of actual spending for the period 2013-2018 including data for the current Fiscal Year 2018-2019. As of January 30, 2019, WISE is projected to come within budget for Fiscal 2018-2019 with a likely carryover of approximately \$8-10K.

Although WISE has played a prominent role in securing a significant level of funding for WISE members – in the order of \$23 million over the past 5 years – the Institute has maintained a strong discipline in its internal management to focus on new research initiatives and enhance communication and outreach objectives. The level of administrative activity at WISE has increased over three-fold since its inception but we have maintained expenditures within the operating budget envelope provided by the Provost's Office at a level of \$350K per year.

The five-year financial plan for WISE for Fiscal 2020-2024 is summarized in Table 5.3.

- WISE is requesting funding support in the amount of \$430K per annum. This is an additional request of \$80K above the currently approved level of \$350K per year. This level of financial support is necessary to achieve our aspirational goals and objectives set out in this Report and specifically to further enhance our capacity for Interdisciplinary Research at University of Waterloo. Please refer to Section 4.2.5 above and Table 5.2 for the 'Rationale for an increase to our Operating Budget'.
- In addition, WISE will continue to seek to external funds to enhance the scope and scale of our activities to be recognized globally as an important source policy advice and research innovation in the energy sector.

Over the next five years, WISE will endeavor to incubate self-sustainable programs and initiatives consistent with our vision to deliver clean energy, affordable and accessible to all.

## 5.2 Use of Funds (Fiscal 2014 – Fiscal 2019)

Budget	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019 (9 months)
	Fiscal 2014	Fiscal 2015	Fiscal 2016	Fiscal 2017	Fiscal 2018	Fiscal 2019
Operating (Provost Office)	200,000	250,000	250,000	300,000	350,000	350,000
Carry Forward	140,248	118,188	119,567	181,320	58,800	49,021
Salary Increase	2,288	2,173	2,761	1,584	4,086	10,030
External Support to WISE	-5,847	4,200	15,400	17,841	0	0
<b>Budget Total</b>	<b>336,689</b>	<b>374,561</b>	<b>387,728</b>	<b>500,745</b>	<b>412,886</b>	<b>409,051</b>
<b>Salary Expense</b>						
Staff Salaries	163,942	134,081	161,645	205,012	264,392	214,001
Co-op Students and Casuals (Part-Time)	24,362	42,360	45,992	27,199	48,858	22,129
Associate Director - Stipends	10,000	10,000	8,250	6,667	0	0
<b>Base Funding - salaries</b>	<b>188,304</b>	<b>176,441</b>	<b>207,637</b>	<b>232,212</b>	<b>313,250</b>	<b>236,130</b>
<b>Operating Expense</b>						
Office (Supplies, Computers, Software, Telephones, Parking, Hospitality)	9,202	8,386	8,504	21,224	23,224	11,087
Travel (Accommodation, Car Rental, Mileage, Airfares)	10,529	13,248	12,583	3,701	14,254	15,657
Communication and Outreach (Public Lectures, Web, WISE Events, Publications)	14,581	15,882	17,005	29,637 <sup>2</sup>	31,385 <sup>3</sup>	59,799 <sup>4</sup>
Global Partnerships and Research Collaboration	22,615	9,158	61,884 <sup>1</sup>	16,763	19,077	27,785
<b>Base Funding - operating expense</b>	<b>56,927</b>	<b>46,674</b>	<b>99,976</b>	<b>71,325</b>	<b>87,940</b>	<b>114,328</b>

1 – This includes \$50,000 for Hydro One projects and \$11,000 for a Roxul project.

2 – This includes a WISE lecture/reception (approx. \$1,100); SDTC workshop (approx. \$1,600); CCRE 2017 forum (approx. \$9,200); and decarbonisation forum (approx. \$2,300)

3 – Promotion and advertising includes web cost (WISE & AE4H portal) approx. \$13,000; professional editing approx. \$1,500. In addition, hospitality includes approx. \$5,000 for WISE Energy Day 2018.

4 – Promotion and advertising includes technical support (A/V equipment) for three events approx. \$10,500; web cost approx. \$7,900; professional editing approx. \$1,600. In addition, hospitality includes RRPW 2018 approx. \$11,600; building science symposium approx. \$6,000; and CCRE forum 2018 approx. \$7,000.

## 5.3 Budget Request (Fiscal 2020 – Fiscal 2024)

**Table 5.3**

	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
<b>Budget</b>	<b>Fiscal 2020</b>	<b>Fiscal 2021</b>	<b>Fiscal 2022</b>	<b>Fiscal 2023</b>	<b>Fiscal 2024</b>
Budget (Request - Provost Office)	430,000	430,000	430,000	430,000	430,000
<b>Budget Total</b>	<b>430,000</b>	<b>430,000</b>	<b>430,000</b>	<b>430,000</b>	<b>430,000</b>
<b>Salary Expense</b>					
Manager, Program Developmen, Partnerships and Finance	82,264	82,264	82,264	82,264	82,264
Manager, Global Programs and Initiatives	78,545	78,545	78,545	78,545	78,545
WISE Interdisciplinary Research (IDR) Fellowship Program (Additional Funding Request)*	80,000	80,000	80,000	80,000	80,000
Communications Specialist	52,688	52,688	52,688	52,688	52,688
Administrative Assistant	54,164	54,164	54,164	54,164	54,164
Co-op Students and Casual Staff	20,000	20,000	20,000	20,000	20,000
<b>Base Funding - salaries</b>	<b>367,661</b>	<b>367,661</b>	<b>367,661</b>	<b>367,661</b>	<b>367,661</b>
	<b>85%</b>	<b>85%</b>	<b>85%</b>	<b>85%</b>	<b>85%</b>
<b>Operating Expense</b>					
Office (Supplies, Computers, Software, Telephones, Parking, Hospitality)	15,000	15,000	15,000	15,000	15,000
Travel (Accomodation, Car Rental, Mileage, Airfares)	12,000	12,000	12,000	12,000	12,000
Communication and Outreach (Public Lectures, Web, WISE Events, Publications)	18,000	18,000	18,000	18,000	18,000
Global Partnerships and Research Collaboration	18,000	18,000	18,000	18,000	18,000
<b>Base Funding - operating expense</b>	<b>63,000</b>	<b>63,000</b>	<b>63,000</b>	<b>63,000</b>	<b>63,000</b>
	<b>15%</b>	<b>15%</b>	<b>15%</b>	<b>15%</b>	<b>15%</b>
<b>Base Funding Total</b>	<b>430,661</b>	<b>430,661</b>	<b>430,661</b>	<b>430,661</b>	<b>430,661</b>

## Note to Table 5.3:

### Rationale for additional funding for the Interdisciplinary Research (IDR) Fellows Program

- WISE acknowledges a gap in our ability to advance and strengthen Interdisciplinary Research (IDR) amongst colleagues in diverse departments and faculties at UW.
- Whereas we have been successful in bringing together external partners (businesses, industry, NGOs, government agencies) to establish large multidisciplinary projects for funding (in the \$1-5 million range) on an opportunistic basis, we lack the academic strength to become the leading academic voice in the complex energy policy landscape, both in Canada and globally.
- In particular, our Advisory Council Members have made cogent observations on the need to engage colleagues in the social sciences and the humanities to help resolve and provide guidance to governments on the political and social challenges of energy infrastructure developments (ie. approvals of pipelines, transmission corridors, energy facilities etc...).
- There is a compelling need, from their perspective, for WISE to develop greater capacities outside of the natural science disciplines, in order to play a leadership role in enhancing constructive dialogue with stakeholder communities, including marginalized and indigenous peoples.
- With additional funding, we intend to set up a program that will bring in leading scholars for short stays at WISE where they will work with our members to develop interdisciplinary initiatives that address pressing energy sector challenges
- These initiatives will generate primary content. WISE will disseminate the outputs widely and provide a focal point for convening groups with strong divergent perspective to advance constructive dialogue and convergence. The products of the endeavor are 'white papers' fully researched and of high academic quality.
- The Visiting Fellows would collaborate closely with faculty members over selected time periods to create a marriage of social sciences, arts, philosophy, political science and the physical sciences and engineering.
- This will enable WISE to build a strong capacity to inform and guide decisions on the complex challenges at the interface of energy technology developments, society, philosophical and ethical issues and the broader political discourse.
- Fellows will be given desk space at WISE's new location in EVOLV1. This space has already been secured.
- We propose to have visiting fellowships filled on a continuous basis. Fellowships will be 3-4 months in duration depending on the availability of fellows. We therefore estimate to host 4-6 visiting fellows per year (average of 5).

**BUDGET:** \$80k/year is requested to run the program based on the breakdown of costs as follows:

<b>Budget Item</b>	<b>Cost/fellow</b>
Travel to/from Waterloo	\$2000
Fellowship budget (for research assistantship, meetings, etc.)	\$2000
Fellowship stipend (average duration 3-4 months)	\$7000
Accommodation in Waterloo	\$5000
<b>TOTAL COST/FELLOW</b>	<b>\$16,000</b>
<b>X5 FELLOWS/YEAR</b>	<b>\$80,000</b>

# Appendix I: Letters of Support

Please refer to Appendix I in the full report for additional letters of support from external organizations and WISE faculty members...

Link: [https://wise.uwaterloo.ca/download/documents/wise-admin/strategic-plans/senate/new\\_folder/letters\\_of\\_support\\_full\\_listpdf?attachment=0](https://wise.uwaterloo.ca/download/documents/wise-admin/strategic-plans/senate/new_folder/letters_of_support_full_listpdf?attachment=0)



FACULTY OF ENVIRONMENT | Office of the Dean  
519-888-4567 | fax 519-746-2031  
uwaterloo.ca/environment

March 21, 2018

Dr. Jatin Nathwani  
Professor and Ontario Research Chair in Public Policy for Sustainable Energy  
Executive Director, Waterloo Institute for Sustainable Energy (WISE)  
University of Waterloo, Waterloo, ON

Dear Professor Nathwani,

I strongly support the renewal of the Waterloo Institute for Sustainable Energy (WISE). The Faculty of Environment has been a key player in WISE since its inception, and we are committed to working even more closely with WISE in the coming years – as WISE relocates into the Evolv1 Building on the north campus, where it will be proximate to the Interdisciplinary Centre on Climate Change (IC3) and the Faculty of Environment’s leaders and activities related to entrepreneurship, economic development and climate change.

Professors and students from the Faculty of Environment regularly participate in and benefit from the events and programs of WISE. Professor Ian Rowlands was Acting Executive Director of WISE in 2014; and three additional faculty members from Environment have been Associate Directors. Since 2013, 21 Environment students have received Energy Council of Canada Fellowship Awards.

WISE offers exceptional opportunities for researchers from the University to engage with external partners on important energy issues, leading to impactful collaborations. The Affordable Energy for Humanity Global Change Initiative, which is a global consortium of researchers and practitioners committed to ending energy poverty through the sustainable deployment of clean technology, aligns directly with the United Nations Sustainable Development Goal #7 (Clean Energy). As such, it also aligns directly with one of four themes that the soon-to-be-launched Sustainable Development Solutions Network (Canada) is addressing and which the Faculty of Environment is hosting, in partnership with the Waterloo Global Science Initiative.

WISE is delivering on its mandate to shape public attitudes, inform energy policy, tackle current problems and create transformative change for the future. I look forward to our Faculty’s continued interaction with WISE in the future.

Sincerely,

A handwritten signature in black ink that reads "Jean Andrey".

Jean Andrey  
Dean  
Faculty of Environment

200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



FACULTY OF SCIENCE | Office of the Dean  
519-888-4567, ext. 30353 | fax 519-746-2543  
rplemieux@uwaterloo.ca | uwaterloo.ca/science

March 7, 2018

Dr. Jatin Nathwani  
Executive Director  
Waterloo Institute for Sustainable Energy

**RE: Support for WISE Renewal**

Dear Prof. Nathwani,

I am writing to express my support for the Waterloo Institute for Sustainable Energy (WISE) in the strongest possible terms.

WISE brings together a wide variety of platforms focused on sustainable energy technologies, systems and policies. As a University institute, WISE has continued to provide assistance to the Science faculty members in the departments of Biology, Chemistry and Earth & Environmental Science in stewarding multiple R&D initiatives since its inception. WISE management has played a significant role in establishing and maintaining effective working relationships with industry partners, government officials, academic researchers, and young entrepreneurs.

WISE has always provided substantial strategic leadership and administrative support to advance research projects, conferences, workshops, and other academic activities to create a strong value for the Waterloo ecosystem. WISE has been a key contributor to the university's broad advocacy and engagement strategy and ongoing awareness campaign for the internal & external community emphasizing the importance of research and commercialization.

Through this letter, I acknowledge WISE's role in nurturing industry-academic relationship and bringing a unique technical capacity to integrate and develop diverse elements of major multi-disciplinary research initiatives and proposals for funding.

I continue to support WISE and look forward to our Faculty's collaboration with the institute in the future.

Sincerely,

A handwritten signature in black ink, appearing to read "R. Lemieux".

Robert P. Lemieux, PhD  
Dean of Science and Professor of Chemistry



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



FACULTY OF ENGINEERING | Chemical Engineering  
519-888-4567 | fax 519-888-4347  
uwaterloo.ca/chemical-engineering

March 15, 2018

Dr. Jatin Nathwani  
Executive Director  
Waterloo Institute for Sustainable Energy

**RE: Support for WISE Renewal**

Dear Prof. Nathwani,

I am writing to express my strong support for the Waterloo Institute for Sustainable Energy (WISE).

WISE brings together a wide variety of platforms focused on sustainable energy technologies, systems and policies. As a University institute, WISE has continued to assist many faculty members of the Department of Chemical Engineering (21 faculty members in CHE are active WISE members) in stewarding multiple R&D initiatives since its inception. Sustainable energy is of strategic importance to the Department of Chemical Engineering. Of particular importance to our Department, WISE has lent its support to multi-disciplinary research initiatives in the areas of low carbon energy technologies, such as CO<sub>2</sub> utilization, which directly benefited a newly hired faculty member. WISE management has played a significant role in establishing and maintaining effective working relationships with the industry partners, government officials, academic researchers, and young entrepreneurs.

WISE has always provided substantial strategic leadership and administrative support to advance research projects, conferences, workshops (e.g. WISE helped organizing an NSERC Partnership Workshop on Smart Energy Network), and other academic activities (such as initial coordination with potential industry partners) to create a strong value for the Waterloo ecosystem. WISE has been a key contributor to the university's broad advocacy and engagement strategy and ongoing awareness campaign for the internal & external community emphasizing the importance of research and commercialization.

Through this letter, I acknowledge WISE's role in nurturing industry-academic relationship and bringing a unique technical capacity to integrate and develop diverse elements of major multi-disciplinary research initiatives and proposals for funding.

I continue to support WISE and look forward to our Department's collaboration with the institute in the future.

Yours truly,

Dr. Eric Croiset  
Professor & Department Chair – Chemical Engineering  
E6 – 3020  
200 University Ave West  
Waterloo, ON N2L 3G1  
519-888-4567, ext. 36472  
ecroiset@uwaterloo.ca



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



FACULTY OF ENGINEERING | Systems Design Engineering  
519-888-4567, ext. 32600  
sydedept@uwaterloo.ca | systems.uwaterloo.ca

May 1, 2018

Dear UW Reviewers,

I am writing as Chair of the Department of Systems Design Engineering, regarding the review and renewal of the Waterloo Institute for Sustainable Energy (WISE).

WISE was launched as an Institute in 2008 to provide a mechanism for facilitating and supporting energy research within the university. Since its inception, WISE has made admirable efforts to draw in members from various academic units across the university and has become the external face of energy research for the university. I do believe it is meaningful to have a single point of contact for industry and government to engage with energy researchers from different faculties.

From the perspective of Systems Design Engineering, we have five faculty associated with WISE. Of those five, only one is particularly active or connected to WISE, however that individual has benefitted strongly from WISE seminars, interactions, and industry research connections, which indeed have led to a number of new research grants coming into the department.

I see a centre which has a successful research agenda and which provides important links bringing together a wide variety of researchers on campus. I also feel that the sustainable energy domain is an essential one for Waterloo to be involved, and where further visibility and presence is badly needed. I very much support the renewal of Waterloo Institute for Sustainable Energy.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul Fieguth".

Paul Fieguth  
Professor and Chair  
Systems Design Engineering  
University of Waterloo  
Waterloo, Ontario, Canada

<https://uwaterloo.ca/systems-design-engineering/>



200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



FACULTY OF ENGINEERING | Electrical and Computer Engineering  
519-888-4567, ext. 32097 | fax 519-746-3077  
ece.uwaterloo.ca

April 9, 2018

Dr. Jatin Nathwani  
Executive Director  
Waterloo Institute for Sustainable Energy

**RE: Support for WISE Renewal**

Dear Prof. Nathwani,

I am writing to express my strong support for the Waterloo Institute for Sustainable Energy (WISE).

WISE brings together a wide variety of platforms focused on sustainable energy technologies, systems and policies. As a University institute, WISE has continued to provide assistance to the faculty members of the Department of Electrical and Computer Engineering in stewarding multiple R&D initiatives since its inception. WISE management has played a significant role in establishing and maintaining effective working relationships with industry partners, government officials, academic researchers, and young entrepreneurs.

WISE has always provided substantial strategic leadership and administrated support to advance research projects, conferences, workshops, and other academic activities to create a strong value for the Waterloo ecosystem. WISE has been a key contributor to the university's broad advocacy and engagement strategy and ongoing awareness campaign for the internal & external community emphasizing the importance of research and commercialization.

Through this letter, I acknowledge WISE's role in nurturing industry-academic relationship and bringing a unique technical capacity to integrate and develop diverse elements of major multi-disciplinary research initiatives and proposals for funding.

I continue to support WISE and look forward to our Department's collaboration with the institute in the future.

Sincerely,

A handwritten signature in blue ink that reads "Vincent Gaudet".

Vincent Gaudet, PhD, P.Eng.  
Professor and Chair  
Department of Electrical and Computer Engineering, Faculty of Engineering  
519-888-4567, ext. 84016  
vcgaudet@uwaterloo.ca



EIT, 200 UNIVERSITY AVENUE WEST, WATERLOO, ON, CANADA N2L 3G1



**UNIVERSITY OF WATERLOO**  
**FACULTY OF ENGINEERING**  
Department of Civil &  
Environmental Engineering

March 5, 2018

Dr. Jatin Nathwani  
Executive Director  
Waterloo Institute for Sustainable Energy

**RE: Support for WISE Renewal**

Dear Prof. Nathwani,

I am writing to express my support for the Waterloo Institute for Sustainable Energy (WISE) in the strongest possible terms.

WISE brings together a wide variety of platforms focused on sustainable energy technologies, systems and policies. As a University institute, WISE has continued to provide assistance to the faculty members of the Department of Civil and Environmental Engineering in stewarding multiple R&D initiatives since its inception. WISE management has played a significant role in establishing and maintaining effective working relationships with the industry partners, government officials, academic researchers, and young entrepreneurs.

WISE has always provided substantial strategic leadership and administrative support to advance research projects, conferences, workshops, and other academic activities to create a strong value for the Waterloo ecosystem. WISE has been a key contributor to the university's broad advocacy and engagement strategy and ongoing awareness campaign for the internal & external community emphasizing the importance of research and commercialization.

Through this letter, I acknowledge WISE's role in nurturing industry-academic relationship and bringing a unique technical capacity to integrate and develop diverse elements of major multi-disciplinary research initiatives and proposals for funding.

I continue to support WISE and look forward to our Department's collaboration with the institute in the future.

Sincerely,

A handwritten signature in blue ink, appearing to read 'C. Haas'.

Dr. Carl T. Haas  
Professor & Department Chair – Civil and Environmental Engineering  
E2 – 2346C  
200 University Ave West  
Waterloo, ON N2L 3G1  
519-888-4567, ext. 35492  
chaas@uwaterloo.ca



**UNIVERSITY OF WATERLOO**  
FACULTY OF SCIENCE  
Department of Earth &  
Environmental Sciences

March 13, 2018

Dr. Jatin Nathwani  
Executive Director  
Waterloo Institute for Sustainable Energy

**RE: Support for WISE Renewal**

Dear Prof. Nathwani,

I am writing to express my support for the Waterloo Institute for Sustainable Energy (WISE) in the strongest possible terms.

WISE brings together a wide variety of platforms focused on sustainable energy technologies, systems and policies. As a University institute, WISE has continued to provide assistance to the faculty members of the Department of Earth and Environmental Sciences in stewarding multiple R&D initiatives since its inception. WISE management has played a significant role in establishing and maintaining effective working relationships with the industry partners, government officials, academic researchers, and young entrepreneurs.

WISE has always provided substantial strategic leadership and administrative support to advance research projects, conferences, workshops, and other academic activities to create a strong value for the Waterloo ecosystem. WISE has been a key contributor to the university's broad advocacy and engagement strategy and ongoing awareness campaign for the internal & external community emphasizing the importance of research and commercialization.

Through this letter, I acknowledge WISE's role in nurturing industry-academic relationship and bringing a unique technical capacity to integrate and develop diverse elements of major multi-disciplinary research initiatives and proposals for funding.

I continue to support WISE and look forward to our Department's collaboration with the institute in the future.

Sincerely,

A handwritten signature in black ink, appearing to read "Dr. David L. Rudolph".

Dr. David L. Rudolph  
Professor & Department Chair – Earth and Environmental Sciences  
EIT – 2033  
200 University Ave West  
Waterloo, ON N2L 3G1  
519-888-4567, ext. 36778  
drudolph@uwaterloo.ca

**UNIVERSITY OF  
WATERLOO**

SCHOOL OF ENVIRONMENT, ENTERPRISE AND DEVELOPMENT (SEED)  
200 University Avenue West, Waterloo, ON, Canada N2L 3G1  
519-888-4567, ext. 38540 | seed.uwaterloo.ca

5 Apr. 2018

Dr. Jatin Nathwani  
Professor and Ontario Research Chair in Public Policy for Sustainable Energy  
Executive Director, Waterloo Institute for Sustainable Energy (WISE)  
University of Waterloo, Waterloo, ON N2L 3G1

Dear Professor Nathwani,

I strongly support the renewal of the Waterloo Institute for Sustainable Energy (WISE). WISE provides University of Waterloo researchers with a great opportunity to develop interdisciplinary projects with broader groups of colleagues than we could achieve on our own. It raises the profile of research and outreach activities at the University of Waterloo and offers strategic connections with partners on and off campus.

Strategically, WISE has played a key role in developing the Affordable Energy for Humanity Global Change Initiative, a global consortium of researchers and practitioners committed to ending energy poverty through the sustainable deployment of clean technology. This initiative aligns perfectly with the United Nations Sustainable Development Goal #7 (Clean Energy) and enables action to be taken to address Sustainable Development Goal #13 (Climate Action). These SDGs are expected to be a high priority for our work with the United Nations Sustainable Development Solutions Network which will announce the University of Waterloo as its Canadian node in May.

WISE has complimentary links with the Interdisciplinary Centre for Climate Change (IC3) which we expect to grow with the planned relocation of WISE and IC3 to evolvl – the net positive energy building under construction on the north campus. Using the building as a demonstration platform for the future where buildings contribute energy to neighbours rather than only being consumers, WISE is expected to increase its influence in public dialogue and the identification of solutions to address critical energy issues in Canada or around the world.

I have benefited as a researcher in projects with WISE colleagues (smart grid technologies; renewables in remote indigenous communities). My students have benefitted from Energy Council of Canada scholarships administered through WISE. Interactions with external partners are enhanced by the reputation established by WISE. A strong foundation has been established and I expect WISE to continue to gain national and international recognition for the University of Waterloo in the future.

WISE demonstrates the collaborative and experiential success of Waterloo. I strongly support its renewal for even greater impact in the future.

Sincerely,



Paul Parker  
Professor and Associate Dean Strategic Initiatives, Faculty of Environment  
[pparker@uwaterloo.ca](mailto:pparker@uwaterloo.ca) 1(519)888-4567 x32791



April 30, 2018

Dr. Jatin Nathwani  
Executive Director  
Waterloo Institute for Sustainable Energy

**RE: Support for WISE Renewal**

Dear Prof. Nathwani,

Since its establishment, the Waterloo Institute for Sustainable Energy (WISE) has helped a number of faculty from the Department of Management Sciences on multiple R&D initiatives. The most recent ones being:

1. Optimization and Machine Learning for Smart Grid Applications (Prof. Bissan Ghaddar)
2. Smart Meter Data Mining (Prof. Lukasz Golab)

I take this opportunity to congratulate you on the leadership role that WISE continues to play in fostering collaboration with industrial partners, enabling multi-disciplinary research projects, and providing research leadership in the area of Sustainability.

I look forward to seeing more of our faculty members involved with the institute. You have our full support.

Sincerely,

A handwritten signature in black ink, appearing to read "Samir Elhedhli".

Samir Elhedhli, PhD, PEng  
Professor and Chair  
Department of Management Sciences  
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200 University Ave. West  
Waterloo, ON  
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[elhedhli@uwaterloo.ca](mailto:elhedhli@uwaterloo.ca)

# **Appendix II: WISE Contribution to UW Strategic Plan**

## A Bridge to the World –

# Innovation for Global Impact

### Objective

*To marshal our capacity for innovation to solve the most high-impact global problems, for achieving sustainable development and to deliver a high quality of life for all.*

### Authors

*Jatin Nathwani*

Professor and Ontario Research Chair in Public Policy for Sustainable Energy,  
Faculty of Engineering and Faculty of Environment,  
Executive Director, Waterloo Institute for Sustainable Energy

*Nigel Moore*

Manager of Global Programs & Initiatives, Waterloo Institute for Sustainable Energy

*Submitted for consideration: August 28 2018*

### About this document

This concept note presents a vision for consideration by the University of Waterloo community to help inform and shape the University of Waterloo strategic planning process – ‘**Bridge to 2020**’. It is not an official UW document but is provided as an **input to the President’s request to assist with the strategic planning process.**

## Vision

The University of Waterloo has established itself as the top innovation university in Canada. Over the past 60 years we have developed a culture defined by ingenuity, creativity, technical know-how and risk-taking. The world needs change-agents with precisely these qualities, but suffused with empathy and a commitment to address problems of social and economic disparity and environmental sustainability. These endemic issues undermine our quality of life and have disproportionately negative impacts on vulnerable populations at home and abroad while posing existential risks to the health of human and natural systems. They include food and water security, conflict and migration, climate change and environmental degradation, and access to quality education, healthcare, sanitation and energy services.

We believe that the University of Waterloo is bound by *duty* and *opportunity* to direct its capacity for innovation to meeting these challenges. Through collaborative interdisciplinary innovation, and social entrepreneurship as a means to deploy solutions, the University can commit its strengths to becoming a global leader in **‘innovation for human betterment’**.

Innovation to serve a noble purpose ought to be a hallmark of every institution of higher learning. From underserved indigenous communities in Canada whose ability to thrive is undermined by a host of urgent and debilitating challenges, to displaced and impoverished communities all over the world that are increasingly vulnerable to economic and environmental upheaval, Waterloo innovation can and should play a catalyzing role in unlocking human potential and uncovering new opportunities for socially and environmentally responsible development. It is the guiding light of these vital issues – not the flicker of industry fads – **that should draw our institution’s gaze** over both the long and short term. **The ‘spirit of why not’** – our institutional mantra – should guide us in this regard. If not us, who? If not now, when?

The university will benefit from an approach to innovation that aims at addressing collective global problems with a purpose explicitly linked to improving quality of life. We will fuel the intellectual journey of our researchers, teachers, students, and staff by focussing their attention toward the most wicked, and therefore worthy, of problems. **The benefits to Waterloo’s international reputation, campus culture, and the quality** and relevance of our teaching and research activities will be significant.

To realize these benefits does not require an **overhaul of the University’s current** strategy, but it requires building on our existing strengths. Waterloo will differentiate itself by deploying what already makes us unique to create novel pathways for solving critical global problems. Technology innovation, entrepreneurship, and experiential learning are three pillars of the Waterloo approach that will serve us particularly well as we build this approach together.

We believe that Waterloo has an opportunity to redefine the innovation narrative: making it more purposeful, inclusive and collaborative. In doing so we will inspire the next generation of Waterloo students and faculty to become a powerful force for good in the world. Accelerating and deploying this innovation on a large scale will improve quality of life for communities and individuals all over the world, no matter how impoverished or disadvantaged. Our solutions will help ensure global environmental sustainability, economic prosperity, and social equity. This is a purpose suitable for an institution with ambitions as lofty as ours.

### Leveraging the current ecosystem

**The University's next strategic plan must do two things: it must inspire the whole campus towards a common, worthy, and bold vision; and it must articulate practical pathways toward realizing the vision, building on past success.**

#### STEM education and technology innovation

The University is a leader in STEM education and technology innovation. Increasingly, we see technology playing a vital role in both uncovering and helping to solve, through myriad ingenious applications, issues that range from food and water security, to climate change, and the delivery of quality health and education for all. A recent and exciting example is in the area of clean energy deployment to address energy poverty. Through a combination of advances in solar photovoltaics, energy storage, electronics and innovations in software and digital finance, affordable and efficient solar energy technology is now lighting up hundreds of thousands of homes across sub-Saharan **Africa and developing Asia. Through the University of Waterloo's 'Affordable Energy for Humanity Initiative', we have seen firsthand the revolutionary progress that STEM innovators can create when they direct their attention toward human betterment. Waterloo's capacity for technological innovation is needed on the world stage,** representing a significant opportunity for recognition as a globally impactful hub of **'tech for good'.**

#### Entrepreneurship

To deploy globally impactful solutions at scale requires another set of capacities beyond the STEM disciplines. Entrepreneurship in particular has become an important vehicle for bringing cutting edge innovations out of the lab and into the field, particularly in an age where public sector leadership of humanitarian issues is rarely of the scale needed to break the back of entrenched challenges. Many of the pioneers of the current off-grid **solar revolution are 'social entrepreneurs' who got their start in university labs at MIT, Oxford, Berkeley, and other institutions of higher learning where their early ideas found the support they needed to grow into financially sustainable and socially responsible technology enterprises.** The world needs an army of these social entrepreneurs, and universities can be critical players in supporting their development. As a leader in entrepreneurship education, Waterloo is again poised to exploit this opportunity for global leadership, which will require a strategic commitment to create a world-class support structure for budding social entrepreneurs.

#### Co-operative education

As a flagship strength of the university, the next strategic plan must leverage co-op and experiential education programs. From our perspective, the co-op program is perfectly **placed to create 'thousands of bridges to the world', through an ambitious program that recruits impactful companies, NGOs, and other organizations that are on the cutting edge of sustainable development innovation as hosts for our co-op students.** Co-op students will benefit from their awareness of international issues and embeddedness within enterprises that are tackling them, while also bringing this experiential knowledge back to campus where they can continue their educational and entrepreneurial journeys to help solve them.

Drawing once again from our own experience in the clean energy sector, WISE has already established an international internship program for UW co-op students that will send 40+ undergraduates to work as paid interns at clean energy social enterprises

that operate in the developing world. Students have already completed or begun internships in Nigeria, Ghana, Uganda, South Africa, Nepal, Malaysia, South Africa and the UK. This program, which receives external funding that is solely directed toward subsidizing the cost for companies to hire our students by providing the students a scholarship, is a model that could be applied across the sustainable development sector. We are working with on-campus partners such as **St. Paul's Greenhouse Social Impact Incubator** to support these students in continuing to work on the problems that they learn about in their co-op experiences abroad once they return to campus.

By matching on-campus resources with external funding the university can create a pipeline of these opportunities, of which we are certain there is considerable and growing demand within the student body. Co-op is already our largest selling point for undergraduate recruitment. We believe that the next generation of prospective students will value access to co-op experiences that allow them to engage with the global issues that they come to university inspired to solve.

### Hands-on learning

Access to hands-on learning opportunities is already a hallmark of the university. Capstone projects, project-based courses, and student-led teams and clubs not only provide great learning experiences for students, but often result in insights and **innovations that find application beyond the classroom. As such, the university's** commitment to enhancing the variety and depth of hands-on, team-based learning opportunities available to students can support the vision described here. A concerted effort should be made to grow the number of project-based course offerings, increase the interdisciplinary focus of capstone and final year projects, and recruit partner organizations that can assist in supplying a pipeline of important problems for students (and professors) to collaborate and help solve. This approach to learning puts a premium on collaboration instead of competition, and teamwork over individual accomplishment. Such an offering would enrich the student experience through increased awareness of global challenges that they care about, and opportunities to make a difference.

### Ideas and approaches

#### Problem-based research

Design and deployment of technologies and interventions for communities that are impoverished, remote and disconnected from global supply chains is incredibly challenging. The complex economic and social dimensions inherent in these issues necessitates a problem-based interdisciplinary approach to research and learning. The university can leverage the need for a holistic and collaborative approach to innovation as a **means to 'expand the innovation narrative' to become more deliberately inclusive** of non-STEM disciplines. Insights from across social science disciplines and the humanities are critical to the design of innovations with positive sociocultural, economic and environmental outcomes.

Taking this a step further, the university has an opportunity to become a leader in **'transdisciplinary' research, wherein non-expert** communities such as those that would be the end-user or receptors of a technological or other intervention are invited into the research process to help scope and frame the problem from the outset. Partnerships with community-based organizations that are on the frontlines of critical global

sustainable development issues would aid the development of a Waterloo approach to transdisciplinary action research.

The university should also recognize and enhance the positive role that research centres and institutes can foster in advancing problem-based interdisciplinary research to **become ‘curators’ of Waterloo’s research, learning and outreach in these areas.** Research centres and institutes can also be relied upon for partnership building.

### Vertically integrated projects (VIPs)

Vertical integration is a useful model for structuring problem-based research activities that are inclusive of many organizational units, researchers, and students, so as to build and transmit knowledge over the long term. VIPs can be established to address a specific problem in a particular domain (for example, a Sustainable Development Goal), with various research, student and support groups contributing to knowledge creation, solutions development and outreach activities relevant to that domain. Research centres, institutes or staffed research support units can act as network facilitators and partnership builders both within the VIP and externally, and through organizing guest lectures, events, and other activities that **‘bring the world to Waterloo’**. Expertise is maintained and built up over time as individuals cycle in and out of the VIP, and as research and entrepreneurial spin-offs, insights to support political decision-making and other outcomes are delivered over time. VIPs where students from all levels and faculty members from across disciplines with an interest in a specific **problem area are able to engage in this way relies on the existence of a clear ‘front door’** and staff support to encourage collaboration and diffusion of knowledge across the network.

This idea is not new. A consortium of 24 leading engineering schools across the US has implemented the VIP model over the past several years. Georgia Tech, for example, is now **home to over 50 VIPs that span the research landscape, “uniting undergraduate education and faculty-led research in a team-based context...[to] create long term research and development experiences...cultivate leadership and mentoring...[and] benefit faculty research programs.”**

### Social enterprise incubation

At Waterloo, we already have an enviable incubation and acceleration ecosystem and strong entrepreneurial spirit within the faculty and student body. The next step is to build a more substantive support system for social entrepreneurs, particularly those interested in international sustainable development. This process has already begun and is being championed by a number of faculty and staff members across the campus (**e.g. St. Paul’s Greenhouse Social Impact Incubator, The Epp Peace Incubator Program**), but more co-ordination and resources are needed, especially with regard to international networking and mentorship that is specifically tailored for international social enterprise.

**The proliferation of ‘challenge competitions’ (such as The Hult Prize and The World’s Challenge Challenge)** that focus on social innovation illustrates a growing trend toward innovation and entrepreneurship as mechanisms for solving global grand challenges. Their popularity amongst UW students, and the success these teams have already had, is an indication that there is strong demand for a more co-ordinated campus-wide effort to support social innovation and enterprise.

With these activities in place, Waterloo can become the next hotbed of STEM innovation and social entrepreneurship for humanitarian change. Our success stories will become our global calling cards.

### Humanitarian engineering

Waterloo is also well-placed to become a leader in a new engineering sub-discipline that is currently **being championed elsewhere**. **‘Humanitarian engineering’ minors, certificates and other emphases** have been established at a number of leading engineering schools abroad, notably amongst large public universities in the United States such as UC Berkeley, Penn State and Ohio State. The sub-discipline integrates social science driven understanding of end-use communities with novel design **concepts such as ‘frugal innovation’ and ‘user-centric design’ to develop an engineering pedagogy** that is uniquely tailored to innovation for poverty-stricken and resource-constrained settings. As the best engineering school in a country that does not have a significant humanitarian engineering program at any other university, Waterloo could champion its own approach and gain international recognition as an innovator in **‘engineering for humanitarian change’**.

### The Sustainable Development Goals (SDGs)

The United Nations Sustainable Development Goals (SDGs) are a useful and well-recognized framework through which to identify and champion issues of consequence at both global and local scales. By embedding **Waterloo’s new strategic emphasis** within the 17 SDGs, we can better ensure both the internal coherence and international relevance of the proposed activities outlined above.

We should be emboldened in this regard by the fact that Waterloo has become the Canadian host institution of the Sustainable Development Solutions Network (within the Faculty of Environment). A number of research centres and institutes (notably WISE and the Waterloo Institute for Nanotechnology) are already beginning to use the SDGs as a framework for illustrating the significance of their work. As mentioned above, VIPs could be established according to the 17 SDGs, and act as nodes for research, teaching, **entrepreneurial and other activities of relevance to the ‘global goals’** to congeal.

### Benefits to the UW community

**Pursuit of the ‘Bridge to the World’ vision outlined here will benefit the university and its various stakeholders in a variety of ways, both big and small.**

### International prestige

**Waterloo has achieved an unparalleled position domestically as Canada’s top innovation university, and one of the best all-around post-secondary institutions in the country. Abroad, the university’s reputation is solid and** trending in the right direction, but does not yet match our ambitions. The university needs more international success stories, and international partnerships and activities that bear these success stories as fruit. Employing the SDGs as a guiding and internationally recognized framework through which to communicate our accomplishments will aid us in this regard. As will our ability to produce visionary social entrepreneurs who harness the technological

know-how and deep understanding of end-use communities that they gain from their Waterloo education. We believe that through leading by example to *serve* the global community, our reputation abroad will significantly benefit. By seeking real-world impact we will gain the greater international prestige that we seek.

### Attracting global ambassadors

The university will benefit from attracting worldly graduate students and globally **recognized faculty who come to see Waterloo as an ‘institution with a noble purpose’**, where their work will contribute to broader efforts to deliver tangible, impactful solutions to the problems that they have defined their career to solve.

Amongst incoming undergraduate students as well, a Waterloo education will grow in attractiveness. Young people are more aware than ever of the global issues that Waterloo will position itself to take a leadership role in tackling. By engaging incoming **students as ‘global citizens’, empowering them to engage in hands-on learning** about the issues that they care about, and creating pathways for their participation in cross-university initiatives to develop solutions, we will not only attract the brightest students but empower them to become global change-makers. **They will become the university’s next generation of ‘global ambassadors’.**

### Expanding the innovation narrative beyond the STEM disciplines

The vision also brings non-STEM disciplines and departments more firmly into the **innovation narrative of the university, organizing the university’s activities around** problems and vertically integrated interdisciplinary teams rather than discrete disciplinary units. This transition will benefit the research environment by not only providing greater access to the research enterprise for students, but also by linking entrepreneurship activities more closely with research outcomes and encouraging research with a greater chance for impact. Waterloo will combine technological and social innovation to create holistic and robust solutions to previously insurmountable real-world challenges. This collaborative socio-technical innovation process promises to reinvigorate and improve the saliency of scholarship at the university and better allow us to become more than the sum of our parts.

### Collaboration over competition for student health and learning

The university must also develop a strategy to combat unhealthy competition and isolation within the undergraduate student body, particularly in the STEM faculties. While some level of stress is impossible to reduce in rigorous academic programs, there are alternative methodologies of teaching and learning that may allay some of the isolation that is felt by far too many of our brightest students. By encouraging collaboration and team-based learning the university can better deliver to students an education that is purposeful, provides a sense of accomplishment and satisfaction, and teaches the teamwork skills that will be demanded of them after they graduate.

Reducing isolation and providing a more social educational environment for students will also aid their ability to contribute effectively in a world that is characterised by constant communication and connection, as well as by ambiguity, uncertainty and rapid change.

### Gender

The university is a member of the global HeForShe campaign and has taken significant efforts to attract and retain more female students in STEM and entrepreneurship programs, where they are currently under-represented. The vision carries forward this commitment in two significant ways, potentially leading to a step-**change in Waterloo's** efforts in this regard.

First, there is concrete evidence that STEM programs with a social or environmental lens attract and retain greater numbers of female students. This has been the case at both Penn State and Ohio State University, where new minor programs in humanitarian engineering achieved approximately 50% female enrollment without any special recruitment effort. Second, gender is increasingly seen as an important lens through which to understand the SDGs (one of which is gender equality). Development practitioners have found success in achieving other SDGs through an approach that has **women's empowerment at its heart. We see this in the clean energy sector, where** empowerment of female entrepreneurs within target communities has often led to better development outcomes than projects that do not employ such a strategy. As a HeForShe member and a champion of innovation for global impact, Waterloo could become a leading global force in shaping socially and environmentally responsible development that empowers women and girls.

### Indigenization

Waterloo should similarly seize an opportunity to align this vision with our indigenization strategy. Many indigenous communities in Canada face significant and confounding social, environmental and development challenges. By establishing deep dialogues and working collaboratively with communities to help solve them, we will not only have an impact here at home, but be able to integrate what is learned from these experiences in order to refine and enhance the collaborative innovation approach that Waterloo will champion at the global level. Recent work at WISE in collaboration with the Waterloo Global Science Initiative (WGSi) on the topic of energy poverty in off-grid indigenous communities highlighted the notable challenges that are faced by remote communities in Canada, as well as the immense opportunities for collaborative innovation that exist to overcome such challenges (see [‘The OpenAccess Energy Blueprint’](#) – Chapter 6).

As we advance our new indigenization strategy it would be a highly positive step for the University to recognize the valuable role that Waterloo innovation could play in creating new sources of economic and social value within resource-constrained communities.

### Alignment with existing objectives

The vision also delivers upon the themes and primary objectives of the previous strategic plan, namely:

- ✓ *Internationalization*: **“Educate graduates uniquely prepared to address the challenges and opportunities of the 21st century” & “Seek global awareness of Waterloo’s research and teaching expertise”**
- ✓ *Entrepreneurship*: **“Promote innovation and entrepreneurship that spans a wide range of needs, including social, political, health, environmental and technological” & “Facilitating student, faculty and staff entrepreneurship in a broad range of fields, including social entrepreneurship”**

- ✓ *Transformational Research*: “Identify and seize opportunities to lead in new/emerging areas” & “Increase interdisciplinary and transdisciplinary research at the global, national and local scale”
- ✓ *Experiential Education*: “Educate outstanding and world-ready graduates whose skills are in high demand globally” & “Expand experiential learning to include service-based activities and international programs”

In conclusion, to advance such a vision requires a wider conversation within the University of Waterloo community to begin to formulate next steps in developing such a strategy. This will require reviewing best practices across post-secondary institutions that have undertaken program and curriculum development that reflect similar priorities. Below and in the accompanying annexes, we include a summary of our own research findings in this regard, to provide initial insights for a broader engagement and program design process at UW.

#### Background research, resources and peers to learn from

WISE has undertaken extensive research to investigate the methodologies employed by universities that have become recognized leaders in sustainable development, humanitarian engineering, social innovation and social entrepreneurship. This research **was conducted in order to inform WISE’s ‘Affordable Energy for Humanity Initiative’**. Our findings are based on extensive interviews with key university administrators and faculty who lead top programs, alongside secondary research. The insights gained have inspired us to develop this document to support the next phase of the strategic planning process at UW.

#### Accompanying documents

Accompanying this document are *three additional documents* (Please see below Annexes) with more information about the research and activities that undergird the strategic vision:

- Annex 1* – Research notes summarizing relevant initiatives at ten leading global universities, utilizing a common framework to compare their development innovation and entrepreneurship activities.
- Annex 2* – **Draft paper on ‘Sustainable Development Innovation: Education, Research and Enterprise Activities at Universities’ submitted in early 2018 to Springer Encyclopedia of Sustainability in Higher Education**
- Annex 3* – 4-page brief summarizing research findings that was presented to the WISE board in January 2018

#### Peers and resources

A number of initiatives elucidated in the attached documents are briefly noted below, with key resources noted for further interest. WISE is in consistent contact with many of the leading voices in this area, including the authors of many of the resources listed below.

- ✓ The Vertically Integrated Projects Consortium includes 24 US universities who have established various VIP programs that foster innovation by involving students in challenging projects embedded in long-term faculty research efforts.  
*Resources:* [“Systemic Reform in Higher Education: The Vertically Integrated Projects Consortium” \(presentation by Consortium Director Ed Coyle\)](#) & [“Vertically Integrated Projects \(VIP\) Programs: Multidisciplinary Projects with Homes in Any Discipline” \(paper presented at 2017 American Society for Engineering Education Annual Conference & Exposition\)](#)
  
- ✓ Arizona State University has undertaken a **transformation to become a ‘New American University’**. **Led by their president Dr. Michael Crow, this process has** seen the university break down disciplinary barriers and create problem-driven research and teaching streams that interface deeply with external stakeholders. Themes of social innovation and sustainability have become deeply embedded in **the University’s core structure. ASU has recently been ranked the top US University for innovation.**  
*Resources:* <https://newamericanuniversity.asu.edu/> & [“Designing the New American University” \(Book by Dr. Michael Crow\)](#)
  
- ✓ The Massachusetts Institute of Technology (MIT) is home to a number of world leading centers and labs at the forefront of research and action related to poverty alleviation, technology for development and social enterprise. These include [D-Lab](#), [The Tata Center for Technology and Design](#), [The Legatum Center for Development and Entrepreneurship](#), and the [MIT Innovation Initiative](#).  
*Resources:* See links above and research note on MIT for more information & [“The Global State of the Art in Engineering Education” \(a report of the ‘New Engineering Education Transformation’, an MIT initiative\)](#)
  
- ✓ TU Delft is recognized as a leader in reforming engineering education to be collaborative and team-based, and to encourage interdisciplinary systems thinking and creativity. Spearheading this effort is aerospace engineering professor Aldert Kamp, whose department was singled out in the MIT New Engineering Education Transformation study as a leading example of forward thinking engineering education.  
*Resources:* [“Engineering Education in the Rapidly Changing World: Rethinking the Vision for Higher engineering Education” \(book by TU Delft Aerospace Engineering Professor Dr. Aldert Kamp\)](#)
  
- ✓ Duke University’s **fundamental commitment to ‘knowledge in service to society’**, and the academic culture that this focus has helped to create, underpins a robust network of programs on campus in the area of social innovation and entrepreneurship, international development, and civic engagement.  
*Resources:* **See research note on Duke for more information & “Scaling Pathways” (a report from the Duke Centre for the Advancement of Social Entrepreneurship on a \$44.5 million USAID/Skoll Foundation program to invest in social enterprises)**

- ✓ Aalto University in Finland houses a number of centres, programs and projects on the theme of global sustainable development. An umbrella organization, Aalto Global Impact, co-ordinates the ecosystem. Activities include a student-centered incubator for social enterprise, a capacity-building exchange program with **developing world universities and a transdisciplinary research project called ‘New Global’ that develops locally co-created sustainable development solutions in a number of developing world regions. A ‘systems’ approach is employed, valuing deep and prolonged partnerships.**  
*Resources: “[New Global](#)” (website) & “[Aalto Global Impact](#)” (website)*
- ✓ The Miller Centre for Social Entrepreneurship at Santa Clara University is the largest university-based social enterprise accelerator in the world. Over 700 social entrepreneur alumni that have raised over \$500M of capital for their ventures to date. Students participate in experiential learning opportunities with enterprises in the network through fellowships. Beyond the **Miller Center, the School of Engineering houses the ‘Frugal Innovation Hub’** which is a touchpoint for humanitarian engineering on campus.  
*Resources: “[Action Research for Social Entrepreneurship Education](#)” (white paper about the center’s strategy by affiliated faculty members)*
- ✓ The Blum Center for Developing Economies at UC Berkeley hosts initiatives including the Berkeley Development Impact Lab (DIL), which brings together interdisciplinary teams to develop innovations to fight poverty. DIL provides seed funding for projects, convenes stakeholders and offers support for early-stage development innovators. The Blum Center also hosts Big Ideas @Berkeley, a social innovation competition with nearly 700 students participating annually.  
*Resources: “[Development Engineering Toolkit](#)” (a guide featuring lessons learned on launching a development engineering program that unites the social sciences and engineering) & “[Big Ideas Toolkit](#)” (a best practices guide for running social innovation competitions on campus).*
- ✓ **Penn State University’s Humanitarian Engineering and Social Entrepreneurship** program takes students on a technology-driven social enterprise journey that begins with basic training on social entrepreneurship and humanitarian engineering, allows them to experience development issues firsthand, and culminates with the development of real social ventures and deep scholarly research into their impacts.  
*Resources: “[Solving Problems that Matter \(and Getting Paid for it\)](#)” (Book on career opportunities for STEM students in the sustainable development sector edited by HESE founding director Dr. Khanjan Mehta)*
- ✓ **Ohio State University’s Humanitarian Engineering Center** exposes students to concrete humanitarian/development challenges through unique courses, a minor for engineering students, a dedicated scholarship program, and opportunities for international field work at project sites.  
*Resources: “[Humanitarian Engineering at The Ohio State University: Lessons Learned in Enriching Education While Helping People](#)” (Journal article by affiliated faculty members)*

## MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter  
Secretariat

Mark Knight  
Director, Centre for Advanced Trenchless Technologies (CATT)

Bernard Duncker  
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean  
Vice-President, Research and International 

DATE: Tuesday April 30, 2019

RE: Support for the Centre for Advanced Trenchless Technologies (CATT), Engineering-based

I am pleased to inform you that, following the presentation from Mark Knight, Director of the Engineering-based Centre for Advanced Trenchless Technologies (CATT), at the Research Leaders Council meeting of April 17, 2019, the Council unanimously recommends support of the renewal of the Centre for Advanced Trenchless Technologies (CATT) for another five-year term to Senate Graduate and Research Council.



## MEMORANDUM

TO: Senate Graduate and Research Council

CC: Kathy Winter  
Secretariat

Mark Knight  
Director, Centre for Advanced Trenchless Technologies (CATT)

Bernard Duncker  
Associate Vice-President, Interdisciplinary Research

FROM: Charmaine B. Dean  
Vice-President, Research and International 

DATE: Tuesday April 30, 2019

RE: One-Month Extension

I have issued the engineering based Centre for Advanced Trenchless Technologies a 1-month extension to June 30, 2019 to accommodate the renewal process as it goes before Senate in June.





March 14, 2019

Senate, University of Waterloo  
Research Leaders Council

**Subject: Renewal of the Centre for Advancement of Trenchless Technologies (CATT)**

The Centre for the Advancement of Trenchless Technologies (CATT) is pleased to submit to the attached report that highlights CATT's mandate, structure, financials, and activities from 2013 to 2018. These activities were in accordance with the 2012-2018 Vision Plan approved by Senate, Dean of Engineering and Department of Civil and Environmental Engineering Chair. Also provided in Appendix I are the Chair of Civil and Environmental Engineering, active faculty members, and industry members strong letters of support for the centre renewal. The CEE Chair letter is also attached to this letter. On March 13, 2019 the CATT Board of Directors voted and approved this report.

The report shows that CATT has met and exceeded its 2013-2018 Vision plan objectives, is financially self sustainable with no institutional or external funding, and has a healthy carry forward. Key highlights of CATT activities include:

1. Over \$2.0 million in revenue from training of Industry Professionals;
2. Over \$3.0 million in research grants that has been used to support PhD, Masters and Undergraduate student training;
3. Organized and hosted over 90 industry training events that trained over 5100 industry professionals;
4. At end of 2018 fiscal year we have a \$254,488 carry forward surplus;
5. Increased faculty involvement that includes UW engineering departments (CIVIL, MECH, SYSTEMS), Earth Science, Accounting and Computer Science;
6. Three-fold increase in CATT annual paying and active industry members since 2006- 30 in 2006 to 90 in 2019;
7. CATT is financially self sustaining without financial support from UW or external operating grants. Thus, CATT is a full cost recovery Centre;
8. CATT continues to increase education and research activities; and
9. CATT has established a strong foundation for continued growth over the next five years.

These accomplishments are the result of efforts from CATT's dedicated and hardworking staff.



**CENTRE FOR ADVANCEMENT OF TRENCHLESS TECHNOLOGIES**  
Building Sustainable Buried Infrastructure since 1994

CATT is requesting renewal until 2024 (five years) so we can continue to expand our research, professional education, and training of highly qualified personnel in the area of buried water infrastructure, renewal, construction, condition assessment and world class asset management.

Respectfully submitted

A handwritten signature in black ink, appearing to read 'Mark Knight', is written over a light blue horizontal line.

Mark Knight PhD, P.Eng.  
Executive Director and Associate Professor Department Civil and Environmental Engineering

Attachments

Letter of Support Chair Department Civil and Environmental Engineering

2019 Centre Renewal Report - Centre for Advancement of Trenchless Technologies (CATT) Activities 2013 to 2018.



March 14, 2019

Senate, University of Waterloo  
Research Leaders Council

**Subject: Letter of Support for renewal of the Centre for Advancement of Trenchless Technologies (CATT)**

Dear Members of the Research Council

It is a pleasure for the Department of Civil and Environmental Engineering to strongly support the renewal of the Centre for Advancement of Trenchless Technologies (CATT) for another term.

CATT is an international leader in trenchless technology research, implementation and education. They also serve our community of municipal engineers, academics and contractors as a critical nexus of knowledge management, networking and learning. With the leadership of the Executive Director and the senior staff, they have become a significant asset to the University of Waterloo, the Faculty of Engineering and the Department of Civil and Environmental Engineering.

CATT also provides a strong bridge between faculty members and Industry, as well as between graduate and undergraduate students and Industry. These industry linkages develop research funding opportunities, co-op positions, and assist with our goal to be recognized as an international leader in research, education and innovation.

Over the past six years CATT has demonstrated exceptional growth in the area of water infrastructural renewal and asset management. This impressive growth has been done while CATT has operated as a cost recovery Centre. In 2018, the Canadian Network of Asset Managers recognized the research contributions from CATT with the Pioneer Award. Graduate students associated with CATT have received awards at international conferences.

In summary, the Department of Civil and Environmental Engineering strongly supports the renewal of the Centre for Advancement of Trenchless Technologies for another term.

Sincerely,

Donald H. Burn, Ph.D., P.Eng.  
Professor and Acting Chair



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# Centre for Advancement of Trenchless Technologies (CATT) Activities 2013 to 2018

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## 2019 Centre Renewal Report



[www.catt.ca](http://www.catt.ca)

March 2019

**Prepared by:**

Dr. Mark Knight, Executive Director

Dr. Rizwan Younis, Technical Director/Research Associate

Michael Hunt, Associate Director Programs and Operations

Alice Seviora, Administrative/Financial Assistant

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Appendix I: Renewal Letters of Support

## EXECUTIVE SUMMARY

The Centre for Advancement of Trenchless Technologies (CATT) was established in 1994 to help municipalities address their buried infrastructure challenges by using trenchless construction methods. CATT is comprised of university, municipal, industry, business and government personnel who are committed to the advancement of knowledge, materials, methods and equipment used to replace or renew aging and deteriorating water, wastewater and stormwater pipelines using environmentally sustainable trenchless construction methods that are an alternative to continuous open cut pipeline replacement. Trenchless constructions methods are proven to reduce traffic congestion in urban environments, reduce greenhouse gas emissions by over 80 percent compared to open cut replacement, and to decrease disruptions to the public and businesses. They are also cost effective methods that can help water utilities eliminate or reduce the well-established buried infrastructure deficit.

Since CATT's formation 25 years ago, it has continued to grow in activity and recognition as an international leader in buried water infrastructure research and professional education. Over the last six years, CATT has followed and exceeded its 2012 Senate Report Vision plan. CATT has continued to show growth in its paying and supporting members, delivery of technology transfers programs, industrial contracts, fundamental research, as well as, faculty and graduate student participation. Over the past six years, CATT has generated \$2.06 million in revenue from professional education and contract services and over \$3.0 million in research grant funding which has been used to support graduate, Co-op and undergraduate students. This has been accomplished with limited staffing and no institutional or external funding other than in-kind support from the University which is greatly acknowledged. CATT also continues to further develop and enhance its national and international reputation for research and professional education excellence in buried infrastructure construction, location, condition assessment, renewal, education, and infrastructure asset management. In 2018 Dr. Knight and the CATT research team were awarded the 2018 Asset Management Pioneer Award by the Canadian Network of Asset Managers (CNAM) and Hamed Mohammadifardi -PhD candidate - was awarded the best Asset Management research paper at the 2018 System Dynamics conference in Iceland and 2018 CNAM conference in Windsor Ontario.

This report describes CATT's mandate, organizational structure, activities, and vision statements for the next five years (2019 to 2024). The financial report shows that CATT is financially self-sustainable, without institutional or external funding, and has a \$254,488 carry forward surplus at the end of 2018. CATT is well managed and has a strong foundation for continued growth in the next five years. Additional information on CATT is available at [www.catt.ca](http://www.catt.ca). Letters of support for renewal from the Chair of Civil and Environmental Engineering (CEE) is provided in Appendix I. The CEE Chair is responsible for CATT accounts and operations. Appendix I also contains strong letters of support for renewal from active faculty members and Industry members.

## Introduction

High quality and safe treated surface and ground water is delivered to houses and business through a series of transmission and distribution pipelines. The used water is contaminated to become wastewater that flows down drains into a series of collection pipelines that are connected to wastewater treatment plants. Provision of clean potable water to businesses and homes is an essential service that many Canadians take for granted with high expectations to perform without loss of service and at a low cost. CATT's goal is to ensure that aging and deteriorating pipelines continue to perform as designed and at the lowest possible cost to end users.

Figure 1 shows the distribution of asset values, based on replacement value, in a typical Canadian municipality. This figure shows that waste water, water, and storm water infrastructure represents 62 percent of municipality's asset value compared to roads that represents 30 percent.

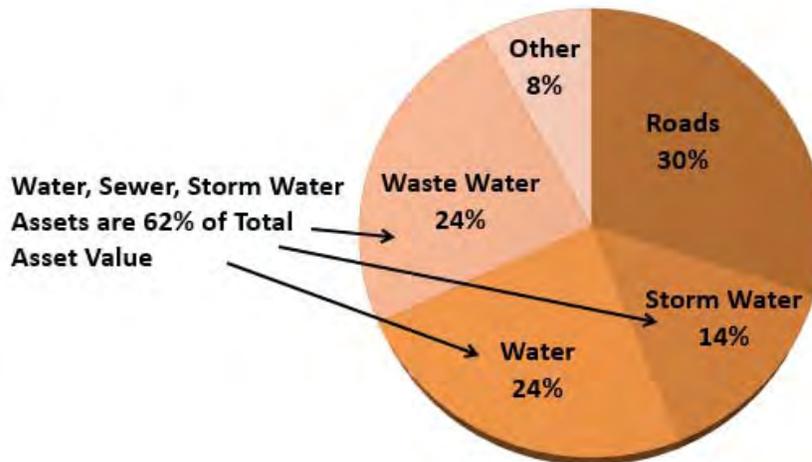


Figure 1. Typical asset value by percentage for Canadian municipalities.

The Federation of Canadian Municipalities published in 2012 the first Canadian Infrastructure Report Card that showed Canada's water and wastewater infrastructure deficit at \$68.6 and \$70.1 billion dollars respectively. Approximately 70 to 80 percent of this deficit is the result of this buried, out of sight, and often forgotten aging and deteriorating linear water and wastewater pipeline having reached and/or passed their design and performance life of 50 to 75 years with little to no maintenance, repair, renovation or replacement. This failing infrastructure is analogous of driving a 50-year-old car with little maintenance and repair and expecting it to perform as a new car. Failure to address this water infrastructure deficit will lead to an exponential increase in operation costs and reduced levels of service that will threaten public health, environment, and economic prosperity of Canada.

Global warming and climate change are also increasing the intensity of precipitation events which has resulted in increased urban flooding events. This flooding is often due to storm water pipelines being under sized and/or deteriorated to the point where they are unable to carry the increased water flows. These ageing and deteriorated storm water pipes have also received little or no maintenance. Trenchless construction methods and infrastructure asset management practices are being used to renew and upgrade storm water pipes to maintain their optimum performance at the lowest possible cost to the public.

CATT's mandate, over the past 25 years, has been to be to serve its members and the public by addressing critical issues facing water, waste water and storm water pipelines' installation, assessment, repair, renewal, and asset management.

This mandate is accomplished by helping municipalities and industry solve and manage their underground infrastructure problems through research, professional continuing education, technology transfer, and the training of highly qualified personnel.

CATT is focused on addressing Canada's linear water infrastructure challenges while at the same time making water affordable to end users. It is one of the only a few centres in North America dedicated to helping municipalities resolve their water infrastructure issues by using innovative trenchless construction methods, technologies and asset management practices.

## Overview of CATT

### Evolution

Premature failures of residential black pipe sewer laterals were noticed by the City of Waterloo in the early 1990's. Many failed laterals were initially replaced using continuous open excavations from house to street connection at a cost of approximately \$6,000 per lateral. In 1994, the City of Waterloo and the University of Waterloo entered into a partnership to explore less expensive and less disruptive black pipe sewer lateral replacement methods. This partnership led to the selection of pipe bursting as a trenchless lateral replacement method that was significantly less disruptive to residents and cost approximately \$4,500 per lateral. The City of Waterloo estimates that pipe bursting has saved the City of Waterloo at least \$4 million – a significant cost saving realized through an industry-academic partnership.

The University of Waterloo, City of Waterloo, National Research Council of Canada, and 25 founding members from municipalities, industrial equipment and material suppliers, contractors, consultants, and gas industry provided initial funding and support for the formation of CATT. The intent of the Centre was to address infrastructure problems faced by municipalities and other public and private entities, and to provide a mechanism for research, training of highly qualified personnel, industry and public education and technology transfer. In November 1996, the University of Waterloo Senate officially recognized CATT as a Centre. CATT is one of UWaterloo's oldest active centres.

## Mission Statement and Objectives

CATT is a grouping of university, municipal, industrial, business and government agencies committed to the advancement of knowledge, materials, methods and equipment used in trenchless technologies. CATT serves its members and the public by addressing critical issues related to underground infrastructure installation, assessment, repair, renewal, and management. This is accomplished by providing a forum for:

- identification of members' research needs;
- initiation and support of fundamental research;
- assistance with the development of new products;
- training of highly qualified personnel in the area of underground infrastructure;
- creation and delivery of professional continuing education programs and technology transfer programs in the area of trenchless construction, condition assessment, and infrastructure asset management;
- support municipalities and water utilities in the identification and application of management systems and technologies;
- development of national and international industry standards, best practices, and specifications; and
- networking with national and international researchers and organizations.

## Vision for 2024

In the next five years, CATT will continue to strive to be recognized as the international leader in trenchless and buried infrastructure research and professional education. This is an achievable goal due to the strong foundation that CATT has built, at the University of Waterloo, over the past 25 years. In addition, CATT will continue to maximize its academic and societal relevance by:

- education and training of Co-op and graduate students as this contributes to providing students with the best overall academic experience;
- continually working with industrial partners in the public and private sectors to promote co-op education and knowledge transfer;
- enhancing institutional capacity to work collaboratively with all Waterloo constituencies, including public and private sectors, and alumni;
- working with industry partners to develop and deliver new and innovative buried infrastructure professional continuing educational initiatives, such as the

Education Program for Civil Infrastructure Professionals (epCIP), that responds to industry and societal needs;

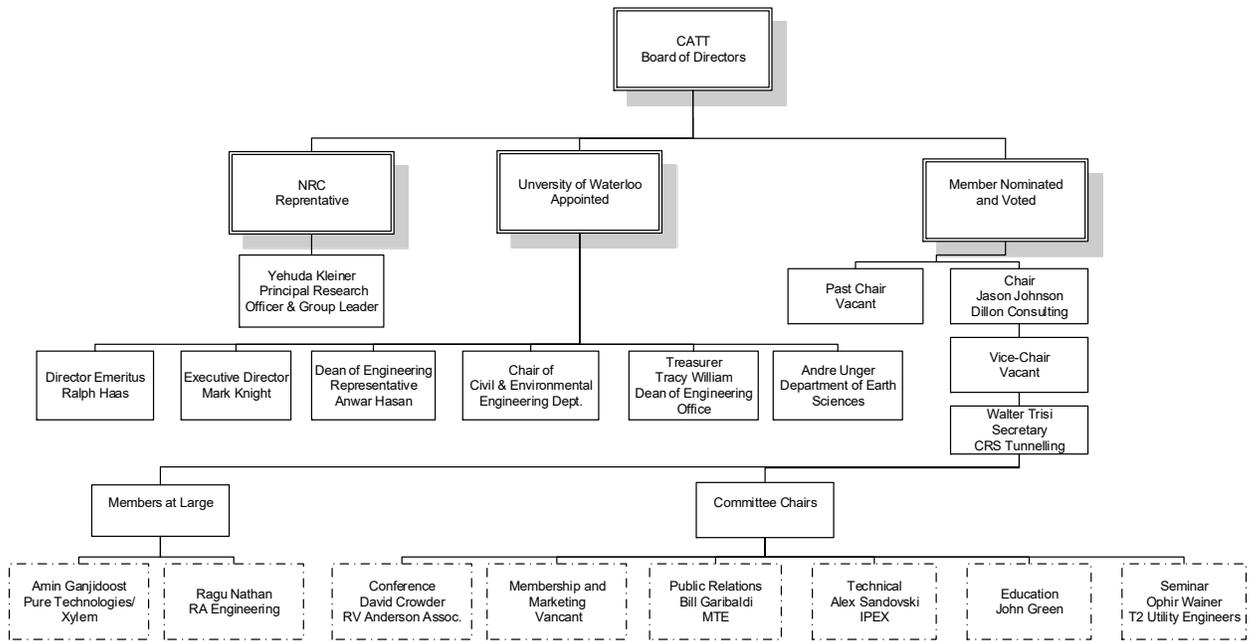
- providing service to society through knowledge transfer; and
- encouraging and supporting innovation.

Furthermore, CATT will continue to be internationally recognized for its leadership in academic programs, scholarship, and societal contributions by:

- pursuing global partnerships in scholarly activities;
- enhancing the quality of student experience and learning through deeper integration of experiential learning and research engagement;
- preparing students to be global citizens by instilling broad diversified awareness, and creating learning opportunities for them in international settings;
- formation of strong alumni links with uWaterloo;
- increasing research and scholarly contribution to society through innovation and transformative research; and
- commitment to provide excellent academic support staff so that CATT can continue high-quality programs, research and services.

## Organizational Structure and Staff

CATT is overseen by a Board of Directors which consists of CATT members' elected from CATT membership and appointed representatives from the University of Waterloo and National Research Council of Canada. The Board meets bi-monthly to set CATT's strategic vision, policies, and budgets and to oversee activities, and financials. Figure 2 shows the 2018/2019 Board of Directors.



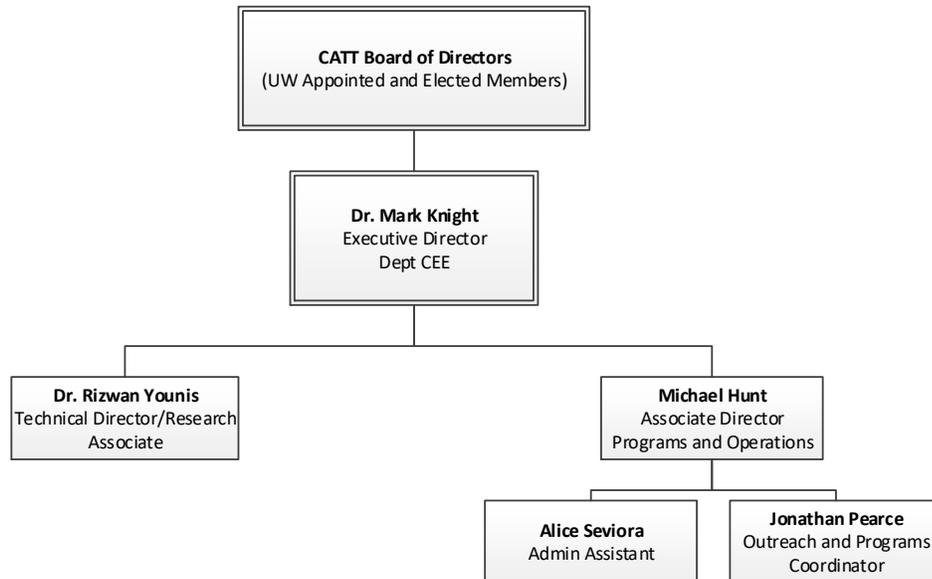
**Figure 2:** CATT’s Board of Directors for the Year 2018/19.

Appointed University of Waterloo representatives are the Chair of the Department of Civil and Environmental Engineering, Dean of Engineering representative, Dr. Andre Unger in Earth Sciences, and Tracy Williams, CPA, CA Faculty Financial Officer whom is CATT’s treasurer. Diane Johnson, in the Office of Research, acted as CATT treasurer until 2018. Dr. Mark Knight, Associate Professor in the Department of Civil and Environmental Engineering has been Executive Director since 2002. The National Research Council (NRC) of Canada appointed representative is Dr. Yehuda Kleiner from the NRC’s Institute for Research in Construction and Urban Infrastructure Group.

Member elected board positions consist of the Chair, Past Chair, Vice Chair, Secretary, Treasurer, and the following committee chairs: Seminar, Membership, Technical, Public Relations and Marketing, Education, and Conference. Additionally, there are two members-at-large positions filled by elected members. Non-Appointed Board members are nominated and voted by the membership in accordance with CATT’s by-laws approved in 2011 are provided in Appendix A. It should be noted that these by-laws need to be updated to CATT’s current operations.

Operating committees are formed by the Board to address changing and emerging industry needs. The Chair of each committee is a representative on the Board of Directors. Active CATT committee members typically advance to the committee chair position and a member on the Board of Directors.

CATT's organizational and staffing structure is shown in Figure 3. It should be noted that as with any business, CATT's organizational structure continues to evolve and change to meet growth, activity, and financial changes. The following sections discuss CATT's Executive Director and staff positions.



**Figure 3:** CATT's 2019 organization and staffing structure.

## Executive Director

The Executive Director is appointed by the Chair of the Department of Civil and Environmental Engineering. This is normally a tenured faculty member in the Department of Civil and Environmental Engineering. The Founding director was Professor Emeritus Bruce Hutchinson. From 1998 to 2001 the Executive Director was Dr. Robert McKim. From 2001 to early 2002 Dr. Ralph Haas, Distinguished Professor Emeritus, acted as Executive Director until the fall of 2002 when Dr. Mark Knight was appointed.

The primary responsibilities of the Executive Director, as established by the Board of Directors and approved by Senate, include:

- Initiating and coordinating the research and education activities of CATT;
- Developing strategic direction and ensuring that the strategic plan is followed;
- Establishing and maintaining linkages with associations, other research centers, and informing CATT members about these activities;
- Assisting the Board of Directors with on-going CATT activities;
- Representing CATT at industry events; and

- Report to the Board of Directors, Dean of Engineering, and Chair of the Department of Civil and Environmental Engineering.

An executive subcommittee consisting of the Board Chair, Vice Chair, and Secretary, Treasurer, and CATT support staff advises and supports the Executive Director.

## Technical Director/Research Associate

In 2011, Dr. Younis was appointed by the Board as the Research Manager. This full time position was funded by CATT research grants and CATT operations account.

The primary responsibilities of the Research Manager include:

- coordinating and conducting CATT's research contracts in the lab and field;
- hiring, training, and managing of co-op students assisting with contract work;
- assisting with graduate students' research;
- preparing research proposals and disseminate findings by preparing reports and presentations for clients; and
- assisting CATT committees to meet their objectives.

With the hiring of the Associate Director of Programs and Operations, the Research Manager position was revised to the Technical Director/Research Associate. Since 2011 Dr. Younis has been involved in CATT's administration and outreach activities, in addition to research, teaching, and contract testing. Due to Dr. Younis' efforts CATT has achieved the financial position and activity level to hire a new team member in January 2019 - Michael Hunt, Associate Director Programs and Operations. It should be noted that filling the new Associate Director position fulfilled a goal stated in our 2012 Senate report. The hiring of Mr. Hunt will allow Dr. Younis to focus on expanding CATT's research and contract activities. Dr. Younis reports to the Executive Director and the Board of Directors. He will also work closely with the Associate Director and other CATT staff. Dr. Younis background and experience is provided in Appendix B.

## Associate Director Programs and Operations

Starting in January 2019, Michael Hunt joined CATT as the Associate Director of Programs and Operations. Prior to joining CATT Mr. Hunt was the Associate Director, Professional Development at the University of Waterloo. Mr. Hunt has extensive experience in professional education, eLearning and marketing. This full time position is funded by revenue generated by CATT professional continuing education and outreach activities.

Mr. Hunt is responsible for the Centre's administration, professional education training programs, conferences, branding, marketing, customer relationship management (CRM), e-commerce and web content management system, staffing, and finance. He

also provides leadership and oversight to the development and management of the Centre for the Advancement of Trenchless Technologies (CATT).

Mr Hunt will be responsible to grow CATT's annual net revenue by expanding existing programs and services and its reputation as an industry leader nationally and internationally.

The Associate Director reports to the Executive Director and the Board of Directors. He also works closely with the Technical Director/Research Associate and CATT staff.

The Associate Director Programs and Operations job description is provided in Appendix C.

### Outreach and Program Coordinator

The Outreach and Program Coordinator is a part time position (3 days a week) filled by Jonathon Pearce in 2017 after he retired from the City of Waterloo. Mr. Pearce has been active as a CATT Board member and volunteer for over 15 years. He is also well connected to the trenchless industry. The role of the Outreach and Program Coordinator is to connect with CATT members to ensure that CATT activities meet industry needs, promote CATT activities at events, and assist with CATT events. This position is funded by revenue generated from membership and professional continuing education.

### Administrative/Financial Assistant

Alice Seviara is the Administrative/Financial Assistant and duties include:

- ensuring that the Associate and Executive Director are up-to-date on CATT's day to day activities and that University and CATT policies are implemented in a timely manner;
- providing updates on the financial and membership status; assisting in the preparation of reports and other documents;
- working with Co-op students; hiring, training, and supervising work-study students;
- liaising with CATT Board members to ensure deadlines and Centre's objectives are achieved. Responsibilities include: maintaining records related to CATT, disseminating information on Centre's activities, initiating meetings, assisting in the preparation of reports;
- acting as a liaison between Board members and Executive Director to ensure Centre's policies are properly followed;
- arranging and organizing conferences, workshops, seminars, and other events, both on- and off-site, sometimes in conjunction with other industry organizations. Tasks include: booking venues/rooms, catering, and travel

arrangements; handling registrations; monitoring expenses and budget; and developing publications for events;

- responding to inquiries by phone and email for information regarding CATT's programs, activities and resources, membership, etc;
- maintaining financial records of budgets, expenses and income for the Centre's accounts to reconcile with the University financial system;
- provide assistance to the Treasurer and Associate Director in financial matters by producing financial reports and providing backup material required for reporting and management purposes;
- generating invoices, and collecting and processing payments for events and services through the Accounts Receivable and Accounts Payable system;
- setting up research contracts with Office of Research, and completing payments, and managing project finances;
- responsibilities for general office administration, including maintaining confidential files, and updating membership database;
- maintaining CATT's website and ensuring that all required updates are completed promptly;
- maintaining office inventory, and purchasing office supplies; and
- performing other duties as assigned by the Executive Director, Technical Director/Research Associate and Associate Director as needed by the Board of Directors and Committees

In 2007, this position was re-classified by the Board from a part-time position (four mornings a week) to a full time position.

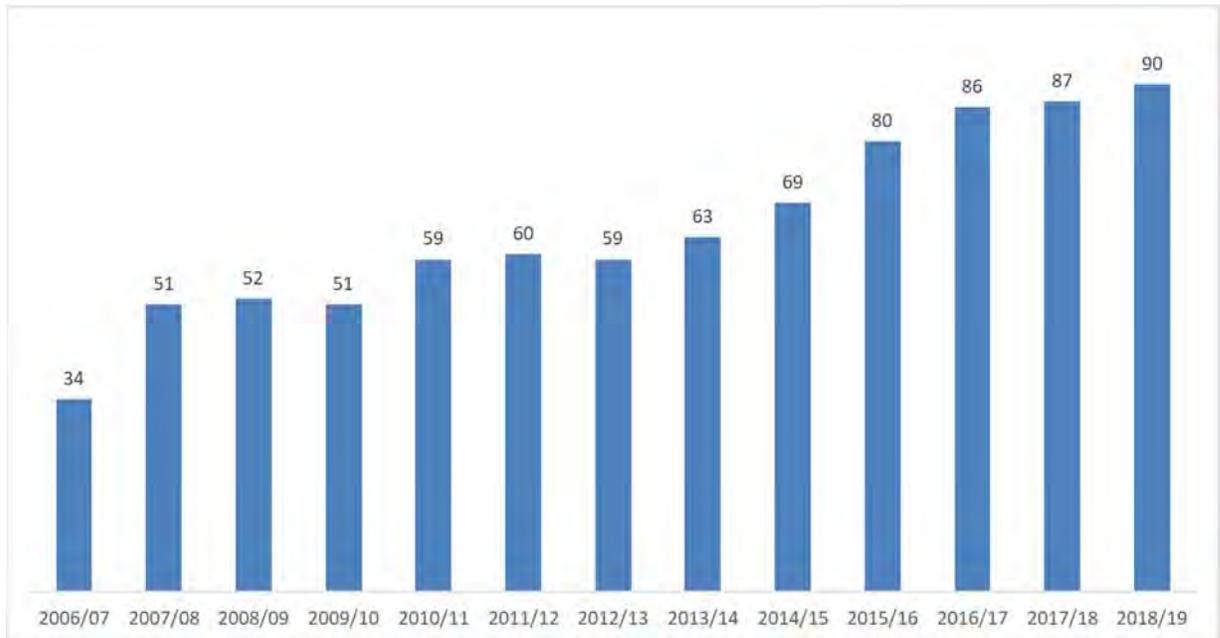
## Support Staff

Since 2012, CATT has employed 71 students to assist with CATT activities: 14 Co-op students, 15 Undergraduate Research Assistants, 37 work study students and five causal students to assist with the completion of research projects, contracts and other CATT activities.

CATT also promotes the involvement of engineering students in the trenchless field by encouraging CATT members to hire uWaterloo co-op students, involving students in trenchless projects and supporting student attendance at the Trenchless Roadshows, workshops and conferences.

## Paying and Supporting Members

CATT's success and existence lies in the strength of its support from municipal and corporate members who participate in the centre and pay an annual membership fee. Figure 4 shows that CATT's fee paying membership has increased from 34 members in 2006/07 to 90 in 2018/19. This continued annual growth shows that CATT is maintaining existing members and attracting new members. This increasing trend shows that CATT activities are meeting the trenchless industry needs. Appendix D provides a list of CATT 2018/19. CATT Annual membership term is the same as the University Financial year (May 1 to April 30).



**Figure 4:** CATT's fee-paying members from 2006/07 to 2017/18.

CATT's fee-paying membership levels are divided into Corporate and Municipal.

Corporate memberships are divided into three levels: Platinum, Gold and Silver. Table 1 shows each corporate level annual fee and benefits. CATT's fees and membership structure has not changed since 2006.

**Table 1:** CATT corporate memberships levels, annual fee and benefits.

<b>CORPORATE MEMBERSHIP</b>		
<b>Platinum</b>	<b>Gold</b>	<b>Silver</b>
<b>\$3,000/Yr</b>	<b>\$2,000/Yr</b>	<b>\$1,000/Yr</b>
Unlimited number of discounts to all CATT events (i.e., conferences, seminars, and workshops) for any corporate employees and or associates (i.e. clients)	Four discounts to all CATT events (i.e. ,conferences, seminars, and workshops) for any corporate employees and or associates (i.e. clients)	Two discounts to all CATT events (i.e. conferences, seminars, and workshops) for any corporate employees and or associates (i.e. clients)
Acknowledgement on website, membership list, and events as a Platinum Member	Acknowledgement on website, membership list, and at events as a Gold Member	Acknowledgement on website and membership list as a Silver member
Large logo on website with web link	Small logo on website with link.	
20% discount on contracts and research projects.	10% discount on contracts and research projects.	
Free listing on CATT's Trenchless Directory for unlimited categories	Free listing on CATT's Trenchless Directory for up to 10 categories	Free listing on CATT's Trenchless Directory for up to five categories

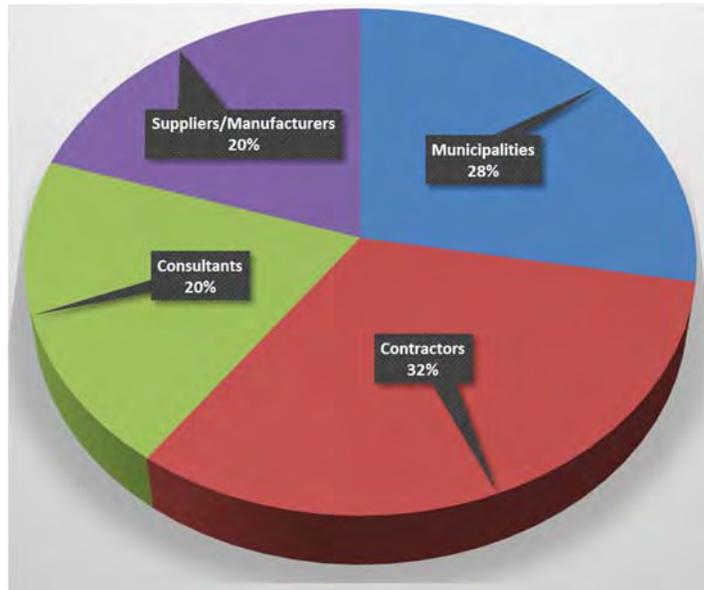
Municipal membership is divided into two levels: Level 1 and 2. Table 2 provides each level annual fee and benefits.

**Table 2:** Municipal membership levels with annual fee and benefits.

<b>MUNICIPAL MEMBERSHIP</b>	
<b>Level 1</b>	<b>Lever 2</b>
<b>\$1,000/Yr</b>	<b>\$500/Yr</b>
<b>Unlimited number of discounts to all CATT events (i.e. conferences, seminars, and workshops)</b>	<b>Two discounts to all CATT events (i.e. conferences, seminars, and workshops).</b>
<b>Acknowledgement on website and membership list as a Level 1 Municipal member</b>	<b>Acknowledgement on website and membership list as a Level 2 Municipal member</b>
<b>Logo on website with link</b>	<b>Logo on website with link.</b>
<b>20% discount on contracts and research projects.</b>	<b>10% discount on contracts and research projects</b>

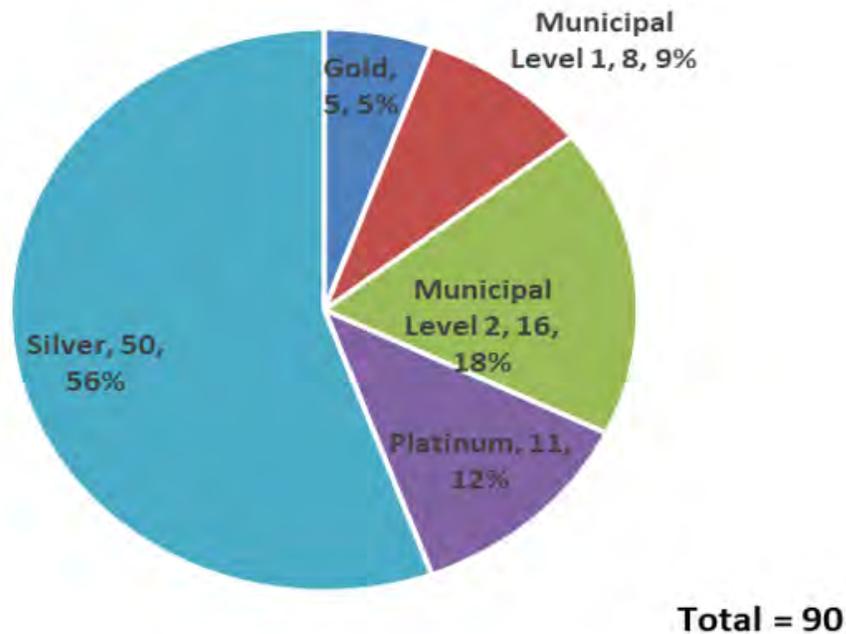
CATT also has a Supporting Organization membership category for organizations that are willing to promote CATT activities to their members and to share a link to CATT's website. CATT also has a student membership category. Supporting Organizations and Student Membership are provided at no cost.

2017-18 fee-paying membership categories as a percentage of the total membership are shown in Figures 5. This figure shows contractors and municipalities represent 32% and 28 % of the membership respectively while consultants, and suppliers/manufacturers represent approximately 40%.



**Figure 5.** CATT 2017/18 fee-paying member category distribution as a percentage of the total membership.

Figure 6 provides the distribution fee paying 2018/2019 Corporate and Municipal Membership by level. Over the past five years, CATT has seen an increase in the number of Platinum membership levels. This increase is attributed to CATT’s outreach, professional, education training, research activities, and impact on Canada’s trenchless industry.



**Figure 6.** CATT 2018/19 fee-paying member level distribution.

## Activities 2012 to 2018

CATT's 2012 Senate Report provided a Vision Plan for 2012 to 2018 that was approved by the Board of Directors. In accordance with the 2012 Vision plan CATT has met and/or exceeded its goals. The following sections provides an overview of CATT's activities over the past five years. These activities provided the University of Waterloo and the Department of Civil and Environmental Engineering with significant national and international exposure.

### Professional Continuing Education and Training Programs

CATT is the leading and largest Canadian trenchless professional education and training provider delivering a variety of continuing education programs for engineers, municipal employees, contractors, suppliers and field technicians. CATT has also developed industry's leading trenchless technology design courses, such as Cured in Place Pipe (CIPP) Good Practices, HDD Design and Construction, and Buried Infrastructure Asset Management. CATT's CIPP course has become the successful NASTT CIPP course that has been developed into the North America Society of Trenchless Technology (NASTT) CIPP Good Practices manual. Since 2012 over 5,100 industry professionals have participated in more than 90 workshops/courses developed and offered by CATT.

All of CATT's workshops and courses are delivered by industry leading professionals and academics. Attendees receive a variety of credits, such as continuing education units from Engineers Canada, professional development credits from CATT, Canadian Construction Association Gold Seal accreditation and credits, and Director Approved continuing education units approved by the Manager of Certification for Ontario Ministry of the Environment and Climate Change (MOECC). These accreditations allow industry professionals to obtain continuing education training credits by attending CATT courses.

CATT's education and training program consists of the following types of workshops and courses. Appendix E provides a list of CATT workshops and courses offered over the past six years.

#### General Workshops

General workshops, designed and delivered by the CATT's Seminar Committee, provide a unique opportunity for participants to learn from industry experts. General workshops include, for example, introduction to trenchless technologies, geotechnical investigations, trenchless rehabilitation and replacement, subsurface utility engineering, pipeline condition assessment, and asset management. These workshops are also offered as pre-event courses at the annual *Canadian Trenchless Technology Road Shows*. Annually CATT's seminar committee plans 10 plus general workshops.

## Technical Workshops

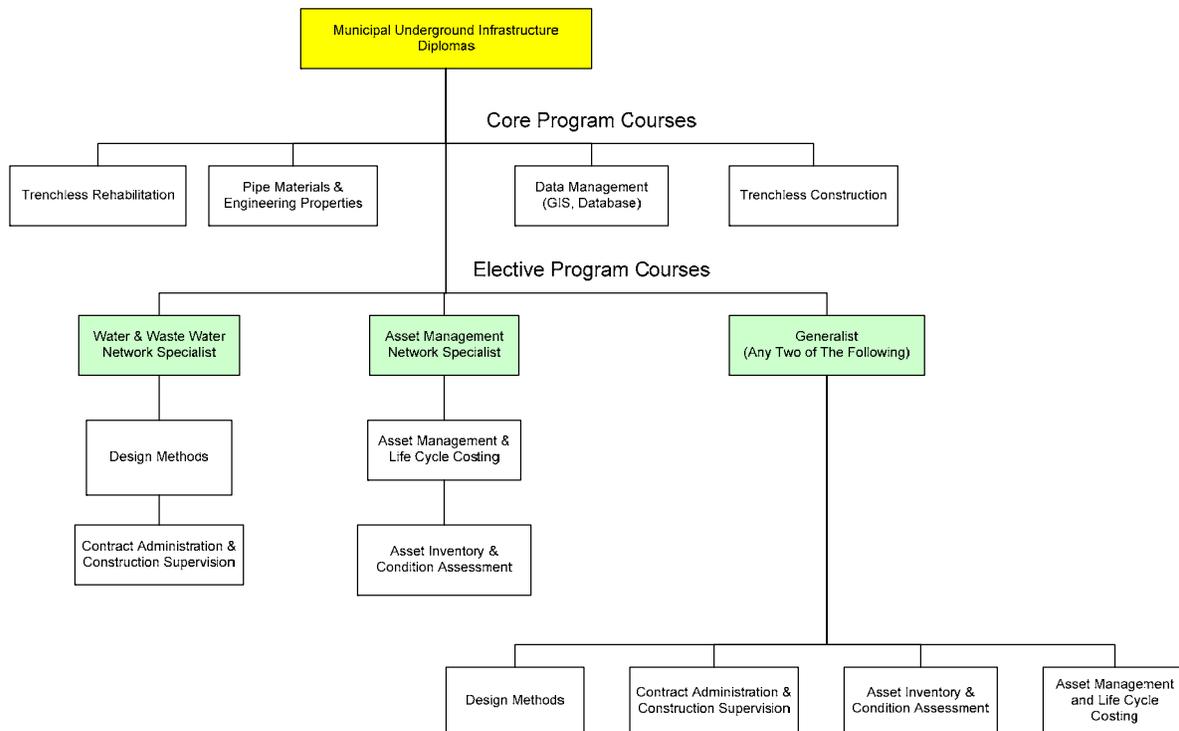
Technical workshops use hands-on and case-based learning approaches for trenchless replacement using horizontal directional drilling and microtunnelling rehabilitation of pressure and gravity pipelines, and water infrastructure asset management. Attendees learn about planning, design, construction, QA/QC, and best practice guidelines for successful delivery of water projects. These courses have also been developed into graduate courses taught in the Department of Civil and Environmental Engineering.

## epCIP - Educational Program for Civil Infrastructure Professionals

In 2004, CATT formed a committee to explore the idea of the development of a diploma program in buried infrastructure. The committee consisting of representatives from municipal, industry and consulting community developed the Educational Program for Civil Infrastructure Professionals (epCIP) that targets the advancement of the skills of professionals in civil underground infrastructure field by offering a series of high-quality engineering courses that lead to a university diploma (currently this is being offered as Buried Infrastructure Specialist Certification). This model is expected to fill the gap between university programs and industry short courses that may be of questionable quality. All courses are designed to have contact hours, assignments, selected readings, and final examinations similar to engineering undergraduate courses.

epCIP provides education distilled and packaged in a format for working professionals that is both accessible and manageable. Academics and recognized industry professionals develop and teach these courses. All courses meet or exceed normal University of Waterloo standards. This program teaches the "why" as well as the "how" and provides education to engineers and related professionals that is timely and relevant to their sectors.

Eight courses that make up the Municipal Underground Infrastructure Diploma are shown in Figure 7.



**Figure 7:** epCIP municipal infrastructure course modules and diploma.

Over the past six years epCIP courses have been developed and offered. The epCIP Asset Management for Buried Infrastructure course has been incorporated as part of the Ontario Good Roads Association (OGRA) Academy for Municipal Asset Management program.

The epCIP program is innovative and unique and has the potential to provide significant revenue to CATT, the Department of Civil and Environmental Engineering and University of Waterloo once fully developed. It will also assist the University of Waterloo to maintain its reputation as an innovator and leader in applied research and education.

#### Partnership Workshops

CATT has partnered with organizations, such as OGRA and Ontario Sewer and Watermain Construction Association (OSWCSA) and the Greater Toronto Sewer and Watermain Contractors Association (GTSECA) to offer high quality workshops. Currently four CATT workshops/Courses are Gold Seal approved by the Canadian Construction Association.

#### Partnership Non-Credit Courses

CATT offers non-credit courses in partnership with OGRA and Fleming College. These courses are equivalent to university level courses with 28 to 35 hours of in-class lectures, group discussions, independent study and/or field work. Course attendees get continuing education credits from the Ministry of Ontario Environment Climate Change (MOECC) and/or Engineers Canada.

## Custom Non-Credit Courses

CATT has developed and delivered customised courses for organizations, such as Enbridge Gas, City of Toronto, and City of Markham. Depending on organizational needs, course duration can vary from one to five days. The topics include general introduction to trenchless technologies, detailed design, QA/QC, and best practice guidelines for various types of trenchless installation and rehabilitation techniques. Course attendees get continuing education credits from the Ministry Ontario Environment and Climate Change (MOECC) and/or Engineers Canada.

## Canadian Trenchless Technology Road Show

Since 2001, CATT in partnership with the Benjamin Media Inc., has organized the Canadian Trenchless Technology Road Shows. From humble beginnings with 10 exhibitors, 20 technical presentations, and 40 attendees in 2001, the show has evolved to become the largest trenchless technology event in Canada with pre-event workshops, live demos, 60 plus exhibitors, over a dozen technical sessions having 60 plus presentations and panel discussions, and more than 500 attendees. The show provides an excellent learning, networking and business opportunity for the trenchless industry and municipalities. Initially the Trenchless Roadshow was held every other year in Ontario. In 2015 CATT partnered with the British Columbia North American Association of Trenchless Technologies to host a Roadshow in Richmond BC. This show is now held in the off year of the Eastern Canada Roadshow. The Richmond show has grown to have over 40 exhibitors and 250 attendees. The 3<sup>rd</sup> Richmond BC Roadshow will be held in May 2019.

## Fostering the Next Generation of Trenchless and Water Industry Experts

CATT provides financial support and a variety of training and educational experiences to graduate, undergraduate, and co-op students. Students get plenty of opportunities to develop their knowledge and skills by participating in CATT's research, contract testing, and pilot projects. They are also encouraged to attend the CATT's education and training events (free of cost) and to network/learn from the industry leaders.

In the last 10 years, over 24 graduate students have completed their MASc or PhD degrees under the supervision of CATT researchers and faculty members. Additionally, CATT provided learning opportunities to over 30 undergrad research assistants and Co-op students on CATT research projects. Industry's leading experts, such as Marc Gelin, principal project engineer at Hatch; Dr. Glenn Duyvestyn, Vice President at Mott MacDonald; Dr. Adedamola Adedapo, Managing Partner at KGS; Shayne Giles, Managing Partner at Dillon Consulting, Dr. Amin Ganjidoost Pure Technologies, and many others trace back their roots to CATT. Similarly, a number of academics including Dr. Sunil Sinha, Virginia Tech and Dr. Alireza Bayat, University of Alberta have been involved with CATT during their PhD tenures at the University of Waterloo.

A list of graduate and post doctoral student supported by CATT sponsored research funds over the past six years are provided in Table 3. Bolded names in this table, indicates PhD candidates.

Table 3 CATT sponsored 2013 to 2018 Master's and PhD candidates.

2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
<b>Amin Ganjidoost</b>	<b>Amin Ganjidoost</b>	<b>Hadi Ganjidoost</b>	<b>Hadi Ganjidoost</b>	<b>Hadi Ganjidoost</b>	<b>Hadi Ganjidoost</b>
Amir Riahi	Amir Riahi	<b>Hamed Fardi</b>	<b>Hamed Fardi</b>	<b>Hamed Fardi</b>	<b>Hamed Fardi</b>
<b>Hadi Ganjidoost</b>	<b>Hadi Ganjidoost</b>	Tyler Gallant	Brandon Shapton	<b>Sevda Payganeh</b>	<b>Sevda Payganeh</b>
<b>Robert Enouy</b>	<b>Hamed Fardi</b>	Brandon Shapton	<b>Sevda Payganeh</b>	<b>Kay Awe</b>	<b>Kay Awe</b>
<b>Shadpour A</b>	Tyler Gallant	<b>Sevda Payganeh</b>	Kay Awe	Saad Ibrahim	Saad Ibrahim
	<b>Jai Jung (Post Doc)</b>	Kay Awe	Saad Ibrahim	Ahmed Abdel-aal	Ahmed Abdel-aal
	<b>Robert Enouy</b>	<b>Robert Enouy</b>	Michael McKinnon/Johnson	Megh Suthar	<b>Milad Khaki</b>
	Kennigton, A	Kennigton, A	Alison Zilstra/Johnson student	<b>Milad Khaki</b>	
	<b>Shadpour A</b>	<b>Shadpour A</b>	Farid Samara	<b>Robert Enouy</b>	
			Ahmed Abdel-aal		
			<b>Milad Khaki</b>		
			<b>Robert Enouy</b>		

It should be noted that graduate students are hired by and assigned to University faculty and not the Centre and that the faculty and graduate students complete research, publications and not the Centre. CATT does however act as a catalyst for the development of research projects, getting faculty involved in buried infrastructure research, and linking researchers with industry partners. The latter is especially important if the University of Waterloo and the Faculty of Engineering wants to meet its goal of increased industry supported research and contracts.

## Faculty Involvement in CATT

Since CATT's inception, many UW researchers have been involved in CATT research and activities. Faculty become involved when they have a direct reason and/or have a direct benefit to be involved. Typical reasons include access to industry contacts for potential funding sources, assistance with obtaining research funds, participation in research grants, participation in graduate student supervision and publications, and participation in graduate student research committee.

UWaterloo faculty that have been actively involved with CATT sponsored research include: Drs. Mark Knight, Carl Haas, Giovanni Cascante, Rebecca Saari, Mahesh Pandey, and Chris Bachmann in the Department of Civil and Environmental Engineering, Dr. David Johnson in Mechanical and Mechatronic Engineering, Dr. Andre Unger in Earth Sciences, Dr. Neil Brisley in Accounting, Dr. Keith Hipel in Systems Engineering, Drs. Chrysanne DiMarco and Kate Larson in Computer Science. Since the last Senate report more UW faculty from more departments across the University have become active in CATT.

External faculty directly involved in CATT activities over the past five years include: Dr. Yehdua Kliener at NRC, Dr. Jai Jung at the Virginia Military Institute, Dr. Ian Moore Canada Research Chair at Queen's University, Dr. Alireza Bayat at University of Alberta, and Dr. Rashid Rehan National Institute of Urban Infrastructure Planning, University of Engineering and Technology, Peshawar, Pakistan. Other external faculty involved in CATT include, Dr. Dragan Savic, University of Exeter UK, and Drs Christopher Rogers, David Chapman and Nicole Metz at the University of Birmingham UK.

Over the past five years graduate students/faculty publications have been produced. In high quality journals with high Impact factors such as Water Research (Impact Factor 7.0). A list of centre related awards and publications are provided in Appendix H.

## State-of-the-Art Research

CATT conducts multi-disciplinary collaborative research with the industry, municipalities and water utilities. These projects have helped to bring innovative asset management tools and new trenchless technologies to the market that have saved municipalities and water utilities millions of dollars. Over the past six years, CATT has undertaken over \$3.0 million worth of research that has been funded by NSERC, Water Research Foundation (USA), Ontario Centre of Excellence, Alberta Innovates, and matching cash and in-kind contribution from Industry partners such as Aegion/Insituform Corporation St Louis MO, Envirolitics, City of Waterloo, Region of Waterloo, City of London, City of Niagara Falls. A description of CATT's research themes over the past five years is provided below.

**Potable Water Pipeline Defect Condition Rating:** In 2013, CATT's researchers were awarded the first University of Waterloo Water Research Foundation grant to develop a potable water pipeline defect condition rating system. As part of this project, CATT developed the Water Pipeline Condition Classification (WPCC) system – the first known such system in the world. Over 13 North American municipalities and water utilities, three major technology providers, and a number of academics and industry experts participated in the project. Similar to the Water Research Council (WRC) in the UK and NASSCO Pipeline Assessment Certification Program (PACP) Sewer Condition Classification systems, the WPCC provides standard language and codes to describe water pipeline structural and operational condition, failure modes and construction features. The proposed WPCC system has the potential to become a standard protocol for water pipeline condition assessment around the world.

**Innovative Asset Management Tools and Advanced Decision Analytics:** Since 2004, CATT has been working on the development of innovative tools and data analytics for buried infrastructure asset management. CATT's asset management research and tools have been developed in partnership with the cities of Niagara Falls, Waterloo, London, Cambridge, and Region of Waterloo. This research is *interdisciplinary* as it crosses the boundary of Civil Engineering, Computer Science, Systems Engineering, and Finance. The researchers have developed the first system dynamic water simulation model, are apply artificial intelligence, machine learning, and Agent based modeling techniques to help solve water infrastructure issues.

The Canadian National Asset Managers (CNAM) awarded the 2018 Asset Management Pioneer Award to Dr. Mark Knight in recognition for CATT's water asset management research. Hamed Mohammadifardi PhD candidate was also awarded the best paper award for his Asset Management research at the 2018 System Dynamics Conference in Iceland and 2018 CNAM conference in Windsor Ontario. KPMG, in Australia, has expressed interest to bring the UW developed asset management tools to Australia's water industry.

**Trenchless Rehabilitation of Pressure Pipelines using Non-Structural Lining Systems:** CATT has helped in the development and commercialization of Tomahawk Water Pipeline Cleaning and Lining System with financial assistance from NSERC, OCE and Envirologics Engineering Inc. Tomhawk is the only system on the market that can clean and prepare the old, rusted water pipe to bare-metal finish to ensure better adhesion of liner to the host pipe. Furthermore, Tomahawk airborne lining (non-structural, AWWA Class I) provides a fast and low cost solution to improve water quality, increase flow and pressure characteristics, and reduce energy cost to pump water through the distribution system. This UWaterloo advanced and verified technology is now being used around the globe to clean and renew watermains. This research was critical for the advancement of the technology and adoption in the industry.

**Trenchless Rehabilitation of Pressure Pipelines using Structural Lining Systems:** In May 2017, CATT was awarded a two-year research grant valued at over \$1 million funded by Aegion/Insituform Technologies, National Science and Engineering Research Council (NSERC), Ontario Centre of Excellence (OCE) and Alberta Innovates (AI). This grant brings together the University of Waterloo and University of Alberta for its first joint inter university research project. At UWaterloo, the research team have constructed and commissioned a unique hydrostatic pressure test facility that can test pressure pipe lining systems under static and dynamic pressures. This unique in North America test facility will be used to advance pressure liner design methods and to improve/verify product performance.

**Industry Best Practices:** Master students with CATT's support have developed industry best practice surveys in the area of water infrastructure asset management and Subsurface Utility Engineering (SUE) practices. Funding for this research has been provided by organizations such as the Southern Ontario Water Consortium (SOWC) and a consortium of industry supporters. Surveys provide quantitative industry data to help Provincial and Federal policy makers understand the water industry so new policies and programs can be developed to establish better industry practices. Over the last two years approximately \$100,000 has been provided to CATT to support this research. Asset Management Ontario and the Federation of Municipalities (FCM) has expressed interest in supporting future surveys to track how industry is changing over time.

## Expert Services

**Contract Research:** CATT develops and carries out pilot projects to evaluate new materials and technologies, and performs specialized contract testing and research for the North American water industry. Often these project lead to industry sponsored and funded research projects. Over the years CATT has gained an international reputation for performing third party type testing for new water rehabilitation products. CATT has also developed and completed field pilot tests for cities (City of Cambridge, City of Waterloo, and City of London) to evaluate new technologies. Over the past five years, CATT has performed approximately 13 contract projects for US and Canadian companies worth approximately \$750,000. Contract testing revenue is used to offset the Technical Director/Research Associate salary and to support graduate, Co-op, and Undergraduate students.

**State-of-the-Art Industry Surveys:** CATT conducts surveys to determine the industry's use of trenchless construction methods in Canada. This data is compiled in a report to establish changes in the industry adoption and use of these construction methods over time and industry trends.

**Industry Leading Advanced Design Tools:** CATT has assisted with the development of industry's leading trenchless design programs that are used by industry practitioners around the globe. Tools include Vermeer Boreaid now owned by the Vermeer Corporation in Pella Iowa, and free web based tools developed for the Plastic Pipe Institute (PPI): PPI-BOREAIID, PPI-PACE, and HDPEAPP. In 2017, a new web based water treatment plant energy calculator was developed for the Southern Ontario Water Consortium.

**Supporting Industry Organizations:** CATT's researchers serve or lead American Water Works Association (AWWA) committees, such as Watermain Rehabilitation, Asset Management, and Watermain Condition Assessment. CATT has organized AWWA workshops for their ACE Annual conference - that has over 12,000 attendees - and the AWWA Water Infrastructure conference. These workshops bring CATT's research to the North American market and CATT international exposure. Furthermore, CATT has participated presented at the ASCE (American Society of Civil Engineering) Pipelines, CNAM (Canadian Water Network) and ORCGA (Ontario Regional Common Ground Alliance) events. CATT is also a supporting member for the Underground Technology Construction conference held annually in the USA. CATT, through Dr. Knight, is a founding member and the only Canadian member of the Plastic Pipe Institute Municipal Advisory Committee. This committee meets twice annually to discuss industry needs and challenges. Dr. Knight is also the Vice Chair of AWWA Watermain Rehabilitation Committee.

**Development of Industry Specifications and Best Practice Manuals:** CATT has helped in the development of Ontario Provincial Standard Specifications (OPSS) that are used by the consultants, contractors, municipalities, Ministry Transportation Ontario (MTO) and other service providers to ensure QA/QC and to improve product/service quality. To date, the following OPSS have been developed through CATT's Technical committee:

1. Condition Assessment of Gravity Sewer Pipes by Measurement of Electric Current Flow Through Pipe Walls
2. Fold & Form PVC Liners for Sewer Pipe Rehabilitation
3. Microtunnelling
4. CIPP for Sewers and Forcemains
5. Watertight Maintenance Hole Cover Systems
6. CIPP for Watermains
7. Laser Inspections
8. Zoom Camera Inspections

CATT developed standards have been used to develop national and international standards. Currently, Dr. Mark Knight, with CATT support, is Chair for the development of AWWA Cured-In-Place Pipe (CIPP) watermain standard. CATT members are also leading or active in the development of AWWA Watermain Rehabilitation Standards:

Sliplining, Cured-in-Place-Pipe, and Spray-in-Place-Pipe. These standards are used by water utilities across North America. CATT's research is helping to establish industry best practices. AWWA also produces industry's best practice manuals. Currently Dr. Knight chairs the revision of AWWA M28 Watermain Rehabilitation committee and has assisted with the revision of AWWA M55. CATT also has developed the North American Cured-in-Place Pipe Good Practice manual.

Currently, CATT is assisting with the establishment of a Canadian Mirror ISO/TC138/SC8 committee. This committee establishes ISO standards on trenchless water and wastewater rehabilitation. CATT participation will increase CATT's and UWaterloo's international reputation as an industry leader and will ensure European industry leaders are aware of CATT activities and research.

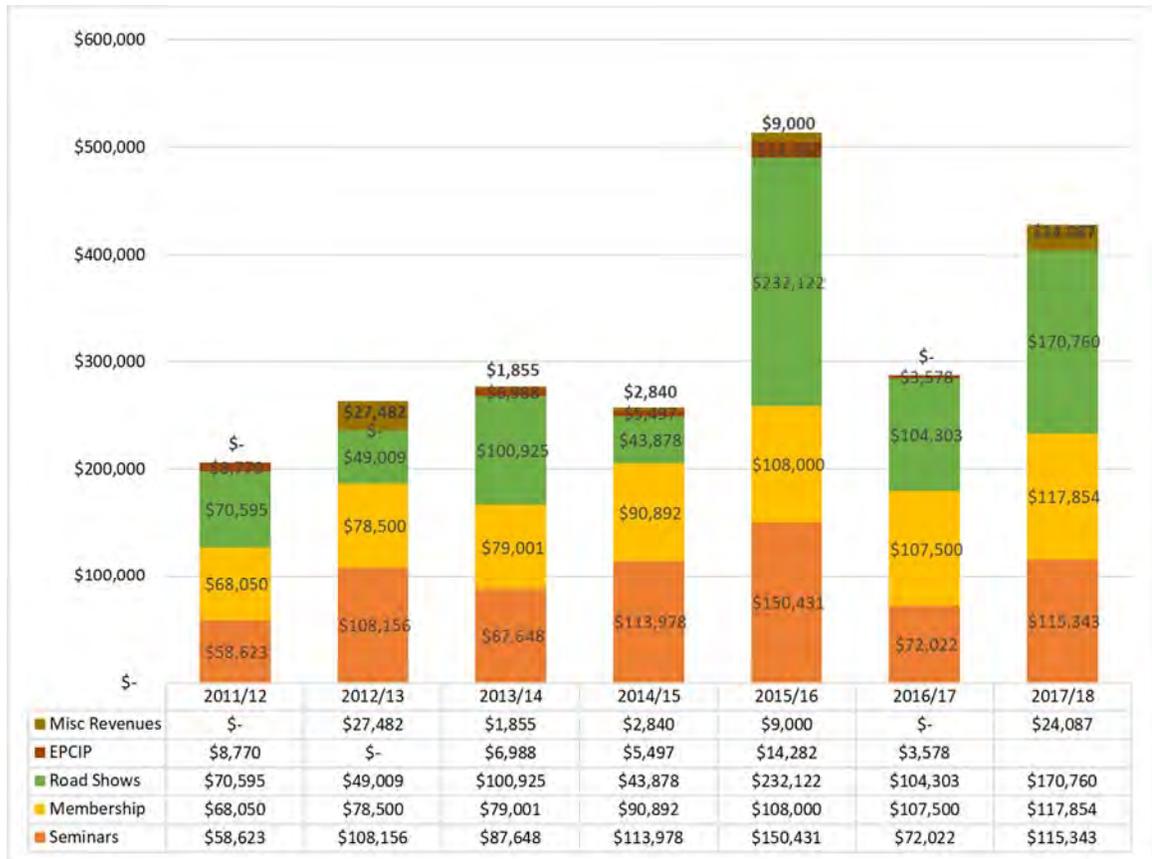
**Annual CATT Awards:** To honour outstanding people, organizations and projects that are instrumental in advancing the trenchless industry locally and internationally CATT has established the follow CATT awards: Trenchless Person of the Year; Trenchless Project of the Year; and Trenchless Firm of the Year awards. In addition, the Roger Crawford award has been established to recognize the best Civil and Environmental Engineering Co-op work reports in the area of trenchless construction.

**Canadian Trenchless Directory:** There was no source of information on the trenchless service and technology providers in Canada, and CATT frequently received queries on a particular technology or service provider. To support this need, CATT has developed the online Canadian Trenchless Directory that provides information about the Canadian trenchless industry including contractors, consultants, manufacturers and suppliers. CATT's Silver, Gold and Platinum members get free directory subscription and listings in addition to other benefits. For a limited time, non-CATT members are also listed on the trenchless directory.

## Finances 2012/13 to 2017/18

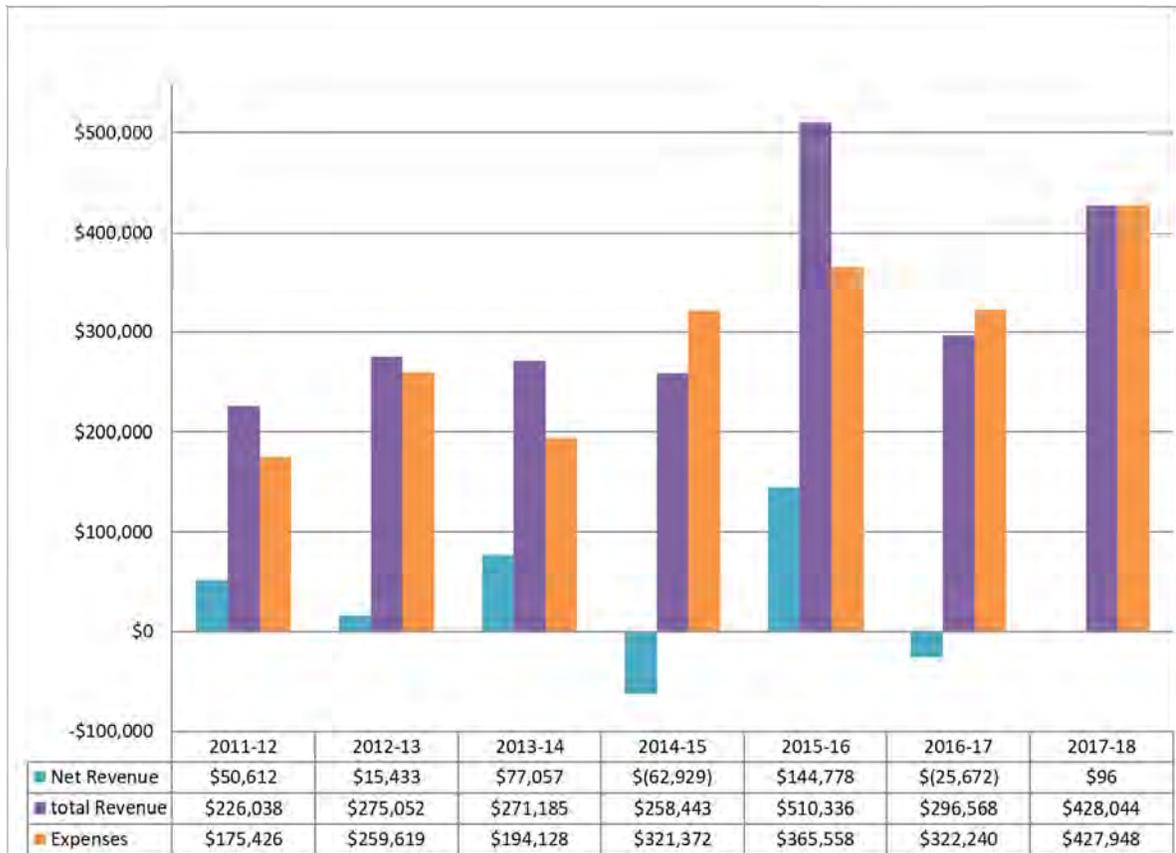
CATT's finances are divided into two sets of accounts: CATT General and CATT Research. CATT General includes revenue and expenses for education outreach and contract testing with accounts that fall under the Department of Civil and Environmental Engineering. CATT Research accounts are projects with work orders that fall the Office of Research. Appendix F provides CATT 2017/18 Year End Financial Statement.

Figure 8 shows CATT's general revenue from 2011/12 to 2017/18. This figure shows that CATT's General Revenue has doubled from \$200,000 in 2011/12 to over \$400,000 in 2017/18. The high in 2015/16 was due to the first BC Roadshow revenue being in this calendar year. CATT Education revenue has generally increased over the last five years from \$100k to \$130k. **Over the past six years CATT generated \$2.06 million of revenue for the University of Waterloo.**



**Figure 8** CATT 2012 to 2018 Workshop, Seminar and Roadshow annual revenue.

Figure 9 shows CATT's revenue, expenses and net revenue from 2011/12 to 2017/18. This figure shows that over the last seven years CATT revenue has exceeded expenses thus generating a cumulative surplus and two small deficits. The small deficit in 2016/17 was the result of lower than anticipated revenue from seminars. The 2014/15 deficit was the result of expenses associated with hosting the first Richmond BC Roadshow. This deficit was covered off in the 2015/16 year after the Roadshow. **At the end of 2017/18 fiscal year CATT's has a carry forward surplus of \$254,488.**



**Figure 9:** CATT's Total Revenue, Expenses and Net Revenue from 2000 to 2013.

The above figures show that CATT is financially self-sustainable/full cost recovery centre, is growing, and has surplus that can be used to cover short-term growth deficits and possible industry shocks. They also demonstrate that CATT is well managed.

Over the past six years CATT Research Accounts have generated over \$3.0 million in research funds. This has been achieved with only two full time CATT staff and CATT member volunteers.

Over the past six years CATT has generated over \$5.0 million in revenue for the University of Waterloo and has a \$254,488 carry forward surplus.

## Vision for 2019 to 2024

### Introduction

In the last six years, CATT has developed an excellent reputation at the local, national and international levels by providing leading edge research and education programs related to buried infrastructure management and trenchless construction fields. CATT has a strong financial position that will allow it to enhance this international reputation and move forward with significant growth.

Consistent annual growth in membership, revenue and increased number of new volunteers on CATT committees and the Board of Directors are strong indicators that CATT is a healthy and relevant organization. It also indicates that the measures introduced over the past six years were positive. With the new hire of the Associate Director of Programs and Operations we can do more. It should be noted that this hire was a goal noted in our 2012 Senate Report.

Education and technology transfer activities have significantly increased over the past six years and, as a result, these have become a significant source of income. We have also established many partnerships with Benjamin Media and other national and international organizations. Over the next five years, we will continue to maintain and/or enhance our partnerships and develop new collaborations. The formation of a formal industry training program, such as epCIP, and the development of new online training will be investigated. Such programs will be developed provided they are able to serve the industry, can generate revenue for the Centre, and are self-sustaining.

Fundamental and contract research activities have significantly increased during the past six years. The hire of Michael Hunt will allow Dr. Rizwan Younis to focus on expanding CATT's research and contract testing. We will apply for new research grants, complete more industry surveys, state-of-the-art reports, pilot studies, and benchmarking initiatives. We will also pursue contract research opportunities that can ensure an appropriate rate of return for the Centre.

We have learned a lot about the growing and changing water/wastewater and trenchless industry, and the operation and funding of the Centre. Our major challenge continues to be the ability to obtain sustainable revenue that can support the personnel resources required to achieve our mandate. We are optimistic that will maintain and grow our municipal and industry members and industry supported research and expert services now that we have hired a new Associate Director of Programs and Operations.

To achieve CATT's mandate during the next five years we will need to:

- ensure that all stakeholders share CATT's vision and mission;
- develop a clear, performance-based strategy that can be monitored to ensure that individuals and members of CATT teams turn the vision and mission into action and results;
- promote effective and empowered teamwork;
- ensure member retention and growth targets are met;
- ensure strong and diverse volunteer targets are met;
- ensure fiscal targets are met and that the Centre continues to be financially sustainable;
- improve marketing of services to its members and the industry;

- improve communication lines from the Board down and members up;
- increase CATT-supported fundamental research with new research partnerships;
- train highly qualified personnel (HQP);
- develop new partnerships with other centers, underground infrastructure organizations and related associations;
- continue the development and delivery of training and education programs such as epCIP; and
- develop industry protocols, good practice guidelines and improve material and installation specifications.

CATT will also continue to strive towards maintaining its reputation as a local, national and internationally recognized Centre of Excellence in the areas of underground infrastructure research, asset management and professional continuing education.

## Action Plan

Every two years CATT Board of Directors and staff have a retreat to: (1) reflect on what CATT has accomplished over the past five years; (2) complete a SWOT (strengths, weaknesses, opportunities, and threat) analysis; and (3) establish key focus areas for the next five years. Details on the 2017 retreat strategic analysis are presented in Appendix G.

### Strategic Planning

To ensure that CATT continues to grow and is relevant to the industry, the Board of Directors will have retreats every other year after the election of the Board of Directors. Focus items for the retreat are:

- ensure the Board understand CATT mandate and role within the University of Waterloo;
- ensure the Board has a common goal and vision;
- review and update on CATT's strategic plan;
- establish key targets to increase CATT's impact on the industry and increase revenue while having a minimal increase in expenses; and
- develop strategy to implement the plan with well-defined goals, objectives, and tasks for the up-coming year.

## Finances

For CATT to succeed it must be financially sustainable. Thus, revenues must meet or exceed expenses. To accomplish this, the following actions will be implemented over the next five years:

- paying membership will increase to over 100 members, and CATT will continue to promote membership at higher fee levels;
- Increase membership revenue from \$110k per year to \$200k per year.
- develop new revenue streams by increasing sponsorship opportunities at CATT events and in CATT's annual magazine newsletter and *Canadian Trenchless Directory*, and by growing the epCIP education programs to be an international UW certification program.
- promote CATT as a provincial and federal centre of excellence in the area of buried municipal research, information dissemination, and education;
- maintain workshop/conference/seminar fees at competitive industry rates and increase marketing through partnerships and use of social media;
- increase education revenue from \$120k per year to \$200k per year;
- increase CATT's annual net profit from the Trenchless Roadshows from \$40k to \$80K by growing the show;
- investigate and promote provincial and/or federal funding for the epCIP program development and delivery;
- develop and market the use of CATT to benchmark new technologies;
- increase contract research from \$750k to \$1.5 million while controlling personnel costs through the use of graduate students, and Technical Director/Research Associate;
- increase research funding and HQP from \$3.0 to 4.5 million;
- apply for grant applications and add, where possible, an item in the budget for CATT's organization of workshops, seminars, project management, use of data servers, etc;
- investigate methods to use the CATT website to generate additional revenue; and
- control and manage personnel costs and expenditures.

## Membership

Without members CATT cannot and will not exist. To retain our existing members and to grow membership to over 100 members, CATT will ensure that members are well served and aware of existing and future activities, resources and member benefits. During the next five years CATT will:

- continue to perform and published annual surveys such as municipal trenchless, asset management and Sub Surface Utility Engineering surveys. These surveys gather data on the state of Canada's trenchless industry;
- continue to develop and expand the trenchless directory for Canada. CATT members will be able to get discounts on advertising and will be listed as CATT member in the directory;
- increase the use of social media and online learning to expand awareness of CATT activities and research to a larger market;
- partner with organizations to broaden CATT membership beyond Ontario;
- develop new literature that highlights the member benefits and CATT's successes. This information will be distributed at CATT events, conferences and other events;
- continue to develop, organize and host industry leading seminars, workshops and conferences that address CATT's vision and the industry's needs;
- redevelop CATT's website to provide its members with more technical information and access to CATT's resources and the trenchless industry; and
- provide members with discount rates on contract research, publications, conferences, seminars, etc.

## Faculty Involvement

Over the past six years, faculty involvement has expanded from mainly in the Department of Civil and Environmental Engineering and Earth Sciences to include faculty members from Mechanical Engineering, Computer Science, Systems Engineering, and School of Accounting and Finance.

Currently we are investigating research funding that will involve faculty members in Chemistry and Chemical Engineering. In 2018, CATT responded to a National Research Council (NRC) request for proposals to investigate the impact of Urban Climate change on storm water infrastructure. The CATT proposal brought together a multi-disciplinary team that consisted of faculty members in Environment, Civil and Environmental Engineering and international researchers. The CATT proposal was not successful. However, CATT will continue to respond to similar proposals that require cross-disciplinary

researchers and increase UW faculty involved in CATT. Increasing faculty involvement will increase HQP training associated with CATT.

## **Operations**

Over the past six years, CATT's increased activities coupled with changes in administrative support systems within the University of Waterloo with respect to invoicing and policy changes have resulted in downloading a significant number of UW provided services to CATT staff and increased costs to CATT.

On an annual basis CATT processes over 1500 registrations for events. To improve efficiencies in event registration, tracking and data management CATT has been working with UW Finance and IST to implement a new event management system. Once implemented this system will be available to UW Centres and organizations.

CATT will continue to implement continuous improvement processes to ensure optimization of limited staff resources.

## **Succession Planning**

Dr. Knight has been the Executive Director since 2002. To ensure CATT's long-term sustainability a succession plan for a new executive director will be developed in 2020 by the Board of Directors subcommittee, the Chair of the Department of Civil and Environmental Engineering, and Dean of Engineering starting.

## **Closing**

Since CATT's inauguration in 1994, CATT continues to meet its mandate approved by Senate, the Dean of Engineering, and the Chair of the Department of Civil and Environmental Engineering.

CATT is a well-managed Centre, and is financially self-sustainable without UW Centre, government or other external financial support. It also has a \$254,000 carry forward surplus. Over the past six years, CATT has met or exceeded its 2012 Senate and Dean of Engineering approved objectives. It has also generated over \$5 million in revenue for the University of Waterloo. Over the past six years, CATT research and professional education activities have significantly increased, through the efforts of two full-time and one part-time staff.

Buried infrastructure continues to age and deteriorate. Recent high profile infrastructure failures have increased the public and political awareness with respect to the importance and need for infrastructure renewal. We believe that numerous opportunities for research, education, and technology development and knowledge transfer exist within the industry and provincial and federal governments over the next five years. CATT, with its strong links between the University, its members, end-users, and researchers, will capitalize on these opportunities. The recent hiring of Michael Hunt, CATT past success, increased public and industry awareness of the need to replace

and/or renovate aging infrastructure will allow CATT to experience significant and continued growth over the next five years.

CATT's Vision Plan and programs will build on the strong foundation established over the past 25 years and will increase faculty involvement, graduate research, research funding, and contract research. It will also continue to work to establish the University of Waterloo and Department of Civil and Environmental as a world leader in buried infrastructure research and education.

## **APPENDICES**

Appendix A: Policies and Procedures

Appendix B: Technical Director/Research Associate Dr. Rizwan Younis CV

Appendix C: Associate Director Programs and Operations Job Description

Appendix D: CATT Membership Directory 2018/19

Appendix E: 2013 to 2018 CATT Workshop and Seminars

Appendix F: CATT 2017/18 Year End Financial Statement

Appendix G: CATT 2017 Retreat SWOT Analysis and Strategic Plan

Appendix H: 2012-2019 Centre Related Publications

Appendix I: Renewal Letters of Support

## Appendix A: Policies and Procedures

# Centre for Advancement of Trenchless Technologies

## Policies and Procedures

Dated: September 18, 2003

Revised: May 3, 2011 (Adopted by the Board: June 9, 2011)

### **A. OVERVIEW**

#### **1. Initial Stimulus and Development**

The initial stimulus for the creation of a trenchless technology research centre at the University of Waterloo (University) came from the City of Waterloo (City). In the early 1990's, the City began experiencing premature deterioration of sewer laterals. Many of the laterals had to be replaced using conventional construction methods, which were considered highly disruptive and expensive. The City decided to investigate more cost effective and less disruptive construction alternatives. In 1994, the City and the University entered into a partnership to explore low cost, less disruptive pipe sewer replacement methods. This partnership led to the founding of the Centre for Advancement of Trenchless Technology (CATT) which was formally recognized by the University Senate as a Research Centre devoted to helping municipalities and others solve their buried infrastructure problems.

The development of a centre was envisaged in three principal stages. These stages are:

1. An informal phase in which an industry network would be developed and common problems being faced by the industry identified,
2. A more formal phase in which fundamental research programs would be initiated within the context of a formal research centre at the University and
3. The creation of an industrial chair in trenchless technology to expand the research base.

#### **2. Name of Centre**

The name of the centre shall be: Centre for Advancement of Trenchless Technologies (CATT)

### **B. CONSTITUTION**

The principal objectives of CATT are:

1. To conduct fundamental and applied research in support of the underground infrastructure industry and its clients.
2. To use these research programs as a vehicle to educate highly qualified personnel for the underground infrastructure industry and its clients.
3. To organize specialized training programs and other technology transfer initiatives for the underground industry and its clients.
4. To provide University co-op students with employment opportunities and research experience in the underground infrastructure area.

5. To support the commercialization of trenchless technologies that will benefit municipalities in their underground infrastructure management.
6. To develop generic specifications for trenchless technologies, including materials and installation specifications.
7. To develop linkages with other centres specializing in underground infrastructure such as the Centre for Expertise and Research in Infrastructure in Urban Areas (CERIU) in Montreal, the Trenchless Technology Centre (TTC) at Louisiana Tech University and the National Research Council Canada (NRCC) Infrastructure Program.

## **C. ORGANIZATIONAL STRUCTURE**

The operating structure for CATT is as follows:

### **1. Operating Committees:**

CATT will generally operate using a committee format. The following standing Committees will be maintained:

1. Technical,
2. Seminar,
3. Membership,
4. Public Relations,
5. Conferences and
6. Education.

Each Committee shall be chaired by a member of CATT who has been elected or appointed by the Board of Directors (Board). Committee Members are not required to be CATT members. Sub-Committees or Special Committees may be established from time to time by the Board who will specify reporting relationships.

### **2. Staff**

CATT will generally operate with the following staff:

1. Managing Director and
2. Administrative Assistant.

#### **2.1 Managing Director**

The Managing Director shall:

1. Be selected and appointed by the CATT Board,
2. Be remunerated on a contract basis and will be reimbursed approved expenses,
3. Maintain and coordinate CATT's day to day activities,
4. Implement the initiatives and policies adopted by the Board,
5. Provide general monitoring and financial control,

6. Be responsible for oversight and support of CATT's committee activities,
7. Administer and assist with research contracts,
8. Prepare CATT's technology transfer publications,
9. Promote CATT's activities and membership benefits.

The Managing Director shall attend all CATT Board Meetings but shall not have voting rights at those meetings.

If the position of Managing Director is vacant, the duties of the Managing Director shall be taken over by the Executive Director (see Article 3.3) who may delegate the duties but not the responsibility.

## 2.2 Administrative Assistant

The Administrative Assistant shall:

1. Be selected and appointed by the CATT Board in accordance with University procedures.
2. Provide secretarial and administrative services to the Staff, the Board and Committee chairs.
3. Be remunerated on a contract basis and reimbursed for approved expenses.

The Administrative Assistant may attend CATT Board Meetings but shall not have voting rights at those meetings.

## **3. Board of Directors**

The Board of Directors (Board) will be comprised of 15 individuals:

- 10 of whom shall be elected from the CATT membership (see Article 3.1) and
- 5 of whom shall be appointed (see Article 3.2).

### 3.1 Elected Positions and Elections

Elected positions are filled through open nominations from CATT members. If more nominations are received than the available positions, an election will be held in a form approved by the current Board that allows for participation of CATT members. All elected Board members must sign a Code of Conduct Agreement in a form approved by the Board. Elected Board members shall serve a minimum one (1) year term starting from the respective Annual General Meeting (AGM).

Elected Positions shall be as follows:

- Vice Chair,
- Chair (filled by Vice Chair from previous term),
- Past Chair (filled by Chair from previous term),
- Secretary,

- Committee Chairs (6 total),
- Member at Large

The Member at Large position will be filled only in the event that the Past Chair is unable to continue on the Board. The goal of filling this position will be to maintain the size of the Board.

### 3.2 Appointed Positions

Appointed positions shall be as follows:

- Executive Director (see Article 3.3)
- Representative of the National Research Centre (NRC) as selected by NRC,
- Representative of the University as selected by the University (normally by the Dean of Engineering),
- Representative of the University as selected by the University (normally by the Chair of Civil and Environmental Engineering),
- Treasurer as selected by the University (Normally by the Office of Research).

### 3.3 Executive Director

The Executive Director shall:

1. Be selected and appointed by the Board and approved by the University Chair of Civil and Environmental Engineering. The Executive Director shall normally be a faculty member in the University Civil and Environmental Engineering Department.
2. Not be provided remuneration by CATT except for reimbursement of approved expenses.
3. Liaise with University and provide advice to Board on matters related to the Centre's operations,
4. Initiate and coordinate the research activities,
5. Develop strategic direction,
6. Ensure that strategic plan is followed,
7. Establish and maintain linkages with associations, other research centers and inform CATT members of these activities,
8. Assist the Board with fund raising activities,
9. Represent CATT at industry events.

The Executive Director shall attend all CATT Board Meetings and shall have voting rights at those meetings.

### 3.4 Board Executive

The Board Executive shall provide Board related direction and guidance to CATT staff on issues that cannot be dealt with in a timely manner by the CATT Board. This will include but not be limited to administering any Board delegated authority for approval of expenditures and CATT financial or contractual commitments.

The Board Executive shall be comprised of

- Executive Director
- Chair
- Vice-chair
- Past chair
- Secretary
- Treasurer

## **D. MANAGEMENT**

### **1. Meetings**

Board meetings will be held with a minimum of 48 hours' notice to all Board members.

1. Attendance at Board meetings by teleconference shall be considered valid for voting purposes.
2. A quorum for a Board meeting is five (5) elected members.
3. The Annual General Meeting (AGM) shall be held once a year, usually in the month of October and on such a day as may be determined by the Board.
4. The Board may call a General Meeting when deemed necessary or a General Meeting shall be called by the Board on written request of not less than 25 percent (25 %) of the membership.
5. At any General Meeting, 10% of the membership attending will constitute a quorum for voting purposes.
6. Simple majority of those in attendance, providing it is on the agenda, shall carry motions at all meetings
7. All meetings are to be held in southern Ontario unless the Board passes a motion to hold a meeting elsewhere and 30 days' notice is provided to Board members in the case of a Board meeting and all CATT members in the case of a General Meeting or AGM.
8. Minutes will be prepared for Board meetings, General Meetings and AGM's.

The guideline for business at Board meetings is as follows:

- (i) Welcome,
- (ii) Approval of agenda,
- (iii) Approval of minutes,
- (iv) Business arising from minutes,
- (v) Financial update,
- (vi) Committee updates,
- (vii) Research update,
- (viii) Other business and
- (ix) Adjournment.

The guideline for business at the AGM is as follows:

- (i) Opening remarks by the Chair,
- (ii) Committee reports,
- (iii) Report on research,
- (iv) Financial report,
- (v) Endorsement/Introduction of new Board,
- (vi) New Chair Address,
- (vii) Keynote Speaker and
- (viii) Adjournment.

## **E. FEES**

Membership fees will be reviewed and approved from time to time by the Board with notification to the membership

Research fees will be determined by the Executive Director in accordance with University policies and guidelines. Prior to starting a project, a detailed budget will be developed that estimates all expenses. The project budget costs will be set to cover all expenses (e.g., labour, overhead, management fees, equipment rental, technician time, consumables, services, travel, etc.) plus a reasonable return to CATT.

At the completion of a project, all remaining project surplus or deficits will be transferred to the CATT General Account to be used by CATT to meet its Mission Statement.

## **G. LOCATION / RESIDENCE**

CATT enjoys the hospitality of the University of Waterloo. Should the University of Waterloo be unable to provide CATT with an operating location and systems, or, in the opinion of the Board, is unable to provide the necessary operating location and systems, the Board will take such steps necessary to find and secure a suitable location.

## **H. DISSOLUTION**

CATT can only be dissolved by a majority vote of the membership. Any vote on dissolution must be accompanied with a plan for disbursement of any retained funds or management of any deficit once all expenses and obligations have been met.

## **I. FINANCIAL**

1. CATT is a not-for-profit organization. This means that all revenue generated by CATT activities will be used to support and advance its mission statement,
2. CATT's operation must be financially self-sustaining,
3. CATT's financial operation shall be consistent with the Board approved budget,
4. Reimbursement of expenses to Staff will be in accordance with standard University of Waterloo policies as may be modified from time to time,
5. Staff will be reimbursed out of pocket expenses and mileage as required to perform CATT business,

6. Board approval is required for all CATT expenditures
7. Board members are to be reimbursed only for expenses specifically approved by the Board on an individual basis.

## **J. SERVICES**

CATT is to provide the following services:

1. Organizing and / or delivering conferences, workshops, seminars and short courses.
2. Development and review of technical specifications.
3. Development and / or delivery of Continuing Education Courses such as epCIP that will be provided through University of Waterloo Continuing Education when appropriate and feasible.
4. Industry certification.
5. Research and Development:
  - a. University of Waterloo Policy 41 is applied for Industry Contract Research.
  - b. For Industry contract research the University of Waterloo Office of Research will prepare a University of Waterloo Sponsored Research Agreement such as provided in Appendix I.
  - c. If necessary the University of Waterloo Office of Research will develop and prepare Non-Disclosure Agreements, such as Provided in Appendix II.
6. 3<sup>rd</sup> Party Professional Services
  - a. A CATT Professional Services Project Agreement is to be completed.

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# Appendix I

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# Policy 41 – Contract\* Research at University of Waterloo

**Established:** April 11, 1972

**Last updated:** September 1, 1976

**Class:** FS

## 1. General

A university supported by public funds should, along with the responsibility of teaching and conducting research, encourage those of its members who are so inclined to provide a service to society by undertaking work aimed at solving social, business and technical problems.

Universities are an important source of potential assistance, not only through the varied academic expertise, but also in sophisticated facilities that they possess.

Society has the right to benefit from its investment in both these capabilities. However, special work, such as that done under contract for a business firm or government department must not adversely affect university standards or be an added expense to the university.

Research done at universities generally involves students, faculty and facilities. Financial support for this research is provided by grants and contracts as well as by normal university budgets. While the distinction between grants and contracts is not always clear cut, there are basic differences:

## 2. Definitions

### *A. Grant*

A grant is financial support for an investigator working in a particular field without any formal detailed stipulations as to the subject matter of such research. Investigators are free to discuss their work with their colleagues and to publish their findings and interpretation of them.

### *B. Contract*

A contract is an agreement providing financial support for an investigator working in a particular field under specific stipulations and conditions as specified in the contract. These stipulations and specifications may specifically outline the scope and nature of the research to be carried out, together with such matters as patent and publication rights, timing, student participation, and confidentiality.

## 3. Scope of Research

The University, in accordance with its function of maintaining a free flow of knowledge, desires that the results of University research be made generally available. While it acknowledges the

general freedom of its personnel to engage in research of their choosing, the provision of departmental resources for contract research will nevertheless be subject to the final approval of the respective Chair (and where necessary the Dean) provided that, in the matter of grants, where such approval is denied an appeal may be made to the Senate Graduate & Research Council.

## **4. Publication Rights**

There are no publication restrictions on research supported by grants and general University funds. On the other hand, when contracts are negotiated, while all efforts should be made to provide for the reservation of academic publication rights to the investigators (if they so wish), these publication rights may in the interest of the sponsor be subject to a reasonable delay. The details of these restrictions are to be included in the contract, and the University investigators made aware of them.

## **5. Confidential Information**

In order to undertake certain work, it may be necessary to disclose confidential information to the person who will either do or oversee the work. This is standard professional practice and such information should be used with discretion.

## **6. Student Participation**

Students may participate in contractual research under the direction of a faculty member. Students who choose to become involved in contractual research must be informed of, and agree by signature to, the terms of the contract, including any stipulations regarding confidentiality and publications. Where graduate students are involved, this research may become part or all of their required thesis presentation, so students' publication rights for such work must be protected by the terms of the contract and the terms affording this protection must be approved by the appropriate academic officers of the Faculty in which the students are registered. This is a matter of utmost importance to the student because the thesis defense is the culmination of the scholarly activities of a graduate student, and includes a public presentation. The basic data and results of experiments pertinent to the thesis presentation must also be open to public scrutiny. Only under these conditions can the merit of the research be properly judged.

Students may be encouraged to participate in contract work insofar as it exposes them to "real world" problems, but this participation should not be coerced or undertaken where the progress of their degree programs would thereby be significantly retarded.

\* Contracts referred to in this document are those undertaken by the University.

(Policy updated July 2003, to reflect amalgamation of Senate Graduate & Research Council.)

# Appendix II

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**SPONSORED RESEARCH AGREEMENT SRA#**

(Title)

Between

**University of Waterloo**  
Office of Research  
Contracts Research and Industrial Grants  
200 University Avenue West  
Waterloo, Ontario N2L 3G1  
(hereinafter referred to as the “**University**”)

and

●  
(hereinafter referred to as the “**Client**”)

**WHEREAS** the University and the Client wish to enter into this agreement to have the University perform the research as set forth in Schedule “A” in accordance with the terms and conditions of this agreement;

**NOW THEREFORE** in consideration of the premises and the mutual covenants, terms, conditions and agreements contained herein, and other good and valuable consideration, the sufficiency of which is hereby acknowledged, the parties hereto agree as follows:

**ARTICLE 1 – DEFINITIONS**

- 1.1 “**Agreement**” means this Sponsored Research Agreement including all attached schedules, as the same may be supplemented, amended, restated or replaced in writing from time to time;
- 1.2 “**Background Intellectual Property**” means proprietary or Confidential Information of the University, Creator(s), or the Client which is disclosed to the other for the purpose of the Research Plan;
- 1.3 “**Confidential Information**” means the specific terms and conditions set forth in this Agreement, and any information, which is disclosed by one party to the other party for the purpose of the Research Plan provided that tangible materials are clearly marked as “Confidential” and any information provided orally or visually is identified as confidential at the time of disclosure, and confirmed as confidential in writing within fifteen (15) days of such disclosure, but shall not include information that:
  - (a) is or becomes generally available to the public other than as a result of any act by a receiving party to this Agreement;
  - (b) is rightfully received from a third party without similar restriction or without breach of this Agreement;

- (c) a receiving party is able to demonstrate, in writing, was known to it on a non-confidential basis; or
  - (d) was independently developed by a receiving party without the use of any of the Confidential Information.
- 1.4 “**Controlled Item**” has the meaning set forth in Section 2.6;
  - 1.5 “**Creators**” means collectively, the Principal Investigator(s) and any University Research Participants;
  - 1.6 “**Effective Date**” means the date shown in Section 13.1 of this Agreement;
  - 1.7 “**Option Period**” has the meaning set forth in Section 7.3;
  - 1.8 “**Principal Investigator**” has the meaning set forth in Section 2.3;
  - 1.9 “**Research Participant Agreement**” has the meaning set forth in Section 2.4;
  - 1.10 “**Research Plan**” has the meaning set forth in Section 2.2.
  - 1.11 “**Research Results**” means the technical information, know-how, copyrights, models, specifications, prototypes or inventions, whether patentable or unpatentable, developed in performance of the Research Plan;
  - 1.12 “**University Research Participants**” means University researchers, including, but not limited to, students, post doctoral fellows, research associates, who participate in the Research Plan;

## **ARTICLE 2 - OBJECTIVES**

- 2.1 The Effective Date of this Agreement is as provided in Section 13.1.
- 2.2 The University shall perform, or procure the performance of, the research plan as set forth in Schedule “A” (the “**Research Plan**”) upon the terms and conditions hereinafter set forth.
- 2.3 The Principal Investigator(s) of the Research Plan shall be \_\_\_\_\_ of the University’s Department of \_\_\_\_\_, and he/she shall be responsible for the technical content of the Research Plan.
- 2.4 Each University Research Participant shall sign a Research Participant Agreement as set forth in Schedule “B”.
- 2.5 Notwithstanding Section 2.2 hereof, the Client and the University agree that until such time as all regulatory requirements have been obtained, including all necessary approvals of any regulatory or research ethics board concerned, no work requiring such regulatory or ethics approvals shall commence (excepting any preliminary preparations which are

not restricted by such requirements). For greater certainty, any delay in obtaining such approvals shall not be considered a default or breach by either the Client or the University.

- 2.6 The Client and the University acknowledge that some research, particularly that in the natural sciences and engineering, may be subject to export control laws and regulations of Canada or the U.S. For example, transmitting the results of, or information about, certain research may require first obtaining an export permit or other authorization. Certain research may also be subject to regulation by the Controlled Goods Directorate (CGD) of Public Works and Government Services Canada (PWGSC), in accordance with the *Defence Production Act* (DPA) and the Controlled Goods Regulations (CGR). Information may be obtained from the CGD Website at [http://www.cgd.gc.ca/cgdweb/text/index\\_e.htm](http://www.cgd.gc.ca/cgdweb/text/index_e.htm).
- 2.7 The Client shall use reasonable efforts to determine whether or not the Research Plan contains or may result in, items subject to these laws and regulations (a “**Controlled Item**”). In the event that a Controlled Item is identified in the Research Plan, then the Client and the University shall comply with all applicable Canadian and U.S. export control laws and regulations. In the event that the Client wishes to include a Controlled Item into the Research Plan at any time during the term of this Agreement, then the Client and the University agree as follows:
- (a) the Client shall promptly notify the University of the Controlled Item’s classification prior to any shipment or transmission to the University;
  - (b) the University may, at the University’s sole discretion, accept or reject the delivery of the Controlled Item; and
  - (c) in the event that the University rejects the delivery of the Controlled Item, such rejection by the University shall not constitute a breach of this Agreement.

### ARTICLE 3 - FEES

- 3.1 In consideration of the University carrying out the Research Plan, the Client shall pay the University the sum of [] dollars (\$[]CDN), which amount is inclusive of overhead expenses.
- 3.2 The sum stipulated in Section 3.1 shall be paid by the Client electronically or by cheque made payable to the University of Waterloo (Attn: Finance Department, ECH, 200 University Avenue West, Waterloo, Ontario N2L 3G1) within thirty (30) days of receipt of invoice(s) according to the following schedule:
- (a)
- 3.3 Invoices to the Client shall be sent to [].
- 3.4 Interest on overdue accounts will be charged at current bank rates on amounts not paid within thirty (30) days of submission of invoice.

- 3.5 The University shall not be obliged to perform any work beyond the Research Plan which would cause the aggregate costs to exceed the amount set forth in Section 3.1.

#### **ARTICLE 4 – RESEARCH RESULTS**

- 4.1 The University, through the Principal Investigator, will provide the Client with progress reports in accordance with the terms set forth in Schedule “A”.
- 4.2 On or within ninety (90) days following the completion of the Research Plan, the University, through the Principal Investigator, will provide the Client with a final report of the Research Results.

#### **ARTICLE 5 - EQUIPMENT**

Unless otherwise agreed upon by the Client and the University in writing, or specifically provided for pursuant to the terms of this Agreement, all equipment and materials purchased by or provided to the University for the carrying out of the Research Plan, shall be, and remain, the property of the University.

#### **ARTICLE 6 - CONFIDENTIALITY**

- 6.1 All Confidential Information will remain the property of its owner or the party that furnished it as the case may be.
- 6.2 For a period of five (5) years from the date of disclosure of Confidential Information, the receiving party agrees to maintain in confidence all Confidential Information disclosed to it with the same degree of care as the receiving party normally takes to preserve its own confidential information of similar grade, but in any event, no less than a reasonable degree of care.
- 6.3 The receiving party may only disclose Confidential Information to persons with a “need to know” who shall be made aware of, and be required to observe and comply with the covenants and obligations contained herein, and the Confidential Information shall only be used for the purpose of the Research Plan.
- 6.4 A receiving party may disclose Confidential Information pursuant to the requirements of a government agency or pursuant to a court order, provided that the receiving party gives the disclosing party sufficient notice to enable it to seek an order limiting or precluding such disclosure.

#### **ARTICLE 7 - INTELLECTUAL PROPERTY**

- 7.1 All aspects and parts of the Background Intellectual Property shall be exclusively owned by its owner and nothing herein shall serve to, or should be construed to transfer any ownership rights whatsoever in the Background Intellectual Property. Such Background Intellectual Property may be used for the purpose of the Research Plan upon terms and conditions to be agreed upon in writing between the parties.

- 7.2 All Research Results shall be owned by the Creator(s). The Creator(s) are required to promptly disclose the Research Results to the University and to the Client.
- 7.3 During the term of this Agreement and for a term of sixty (60) days following the date of the final report from the Creator(s) disclosing the Research Results (the “**Option Period**”), the Client will have an exclusive option to negotiate a license to the Research Results owned by the Creator(s). The Client shall notify the University in writing, during the Option Period, indicating whether or not the Client will exercise its option. Should the Option Period elapse without the Client responding to the University, the Client shall be deemed to have rejected this option in relation to the Research Results. For greater certainty, the Creator(s) then shall be entitled to grant licenses in regards to, and otherwise commercially exploit the Creator(s) interest in and to the Research Results without restriction or obligation to the Client.
- 7.4 The parties agree the University will specifically retain the right to use the Research Results for continued research and educational purposes without charge, fee, or royalties notwithstanding any agreement on commercial rights as referenced in Section 7.3.

#### ARTICLE 8 - PUBLICATION

- 8.1 The Client and the University agree that it is part of the University’s function and policies to disseminate information and to make it available for the purpose of scholarship.
- 8.2 At any time during the term of this Agreement, the University will provide the Client with a draft copy of any proposed publication or disclosure of Research Results for its review at least sixty (60) days before submission for publication or disclosure. Upon the Client’s written request, which shall be received by the University within the same sixty (60) day period, the University will:
- (a) delete any Confidential Information of the Client from the proposed publication or disclosure; or
  - (b) delay publication, subject to Section 8.3, up to a maximum of sixty (60) additional days for the purposes of filing for intellectual property protection on terms and conditions to be negotiated and agreed upon by the Client, the Creator(s) and the University.
- 8.3 Notwithstanding Subsection 8.2(b), the University retains the right to have any thesis reviewed and defended without delay for the sole purpose of academic evaluation in accordance with the University’s established procedures. The University will, in consultation with the student and the Client, determine if such a publication delay as set forth in Subsection 8.2(b) will be provided. The Client may request that a thesis defense be held in camera and that the members of the thesis examination board, including the external examiner(s), be required to sign a non-disclosure agreement. The University shall determine in its sole discretion if such request shall be granted.

## **ARTICLE 9 - INDEMNITY**

- 9.1 The Client agrees to indemnify and save harmless the University, its affiliates, directors, officers, employees, agents, students and representatives from and against all claims, demands, loss, costs, damages, actions, suits, or other proceedings (individually a “**Claim**” and collectively the “**Claims**”) by any third party based upon, occasioned by, or attributed to actions, errors, omissions, or negligence of the Client its directors, officers, employees, agents or representatives during the performance of this Agreement, except to the extent such Claim(s) are attributable to the gross negligence or wilful misconduct of the University.
- 9.2 The University agrees to indemnify and save harmless the Client, its affiliates, directors, officers, employees, agents and representatives from and against all Claims by any third party based upon, occasioned by, or attributed to actions, errors, omissions, or negligence of the University its directors, officers, employees, agents or representatives during the performance of this Agreement, except to the extent such Claim(s) are attributable to the gross negligence or wilful misconduct of the Client.
- 9.3 The indemnity in this Article 9 shall not affect or prejudice a party from exercising any other rights it may have under the law.

## **ARTICLE 10 – REPRESENTATIONS AND WARRANTIES AND LIMITATION OF LIABILITY**

- 10.1 Each party represents and warrants to the other party that it is duly organized, validly existing and in good standing, and it has the right and authority to enter this Agreement and do all acts and things as required or contemplated to be done, observed and performed by it hereunder.
- 10.2 The University makes no warranty, express or implied, concerning the Research Results under this Agreement, which are all provided “as is”. THE UNIVERSITY MAKES NO REPRESENTATIONS AND EXTENDS NO WARRANTIES OF ANY KIND, EITHER EXPRESS OR IMPLIED. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR THAT THE USE OF THE RESEARCH RESULTS WILL NOT INFRINGE ANY PATENT, COPYRIGHT, TRADEMARK OR OTHER PROPRIETARY RIGHT OF ANY THIRD PARTY.
- 10.3 NEITHER THE CLIENT NOR THE UNIVERSITY WILL BE LIABLE TO THE OTHER FOR ANY CONSEQUENTIAL DAMAGES, LOST PROFITS, LOST SAVINGS, LOSS OF ANTICIPATED REVENUE OR ANY EXEMPLARY, PUNITIVE, SPECIAL OR INDIRECT DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

## **ARTICLE 11 - INSURANCE**

- 11.1 Client shall obtain and maintain comprehensive general liability insurance and any other insurance, for example but not limited to, pollution liability insurance as circumstances warrant, that a prudent person would deem necessary, in the minimum amount of

\$5,000,000 with respect to its operations. Such insurance shall name the University as an additional insured and shall contain provisions for cross-liability and severability of interest, and the Client shall provide a certificate of insurance as evidence of such coverage if requested by University.

- 11.2 University shall obtain and maintain comprehensive general liability insurance and any other insurance, for example but not limited to, pollution liability insurance as circumstances warrant, that a prudent person would deem necessary, in the minimum amount of \$5,000,000 with respect to its operations. Such insurance shall contain provisions for cross-liability and severability of interest, and the University shall provide a certificate of insurance as evidence of such coverage if requested by the Client.

#### **ARTICLE 12 – PERMITS, LICENSES & SUBCONTRACTS**

- 12.1 For work to be carried out off the University's premises, the Client shall identify any permits, licenses or other required by any governing authority in relation to any of the work to be performed and agrees to obtain or to assist the University to obtain such permits, licenses or other.
- 12.2 In the event that any portion of the Research Plan will be performed by a subcontractor, the University and the Client acknowledge and agree that:
- (a) such subcontractor shall be legally bound to a work-for-hire agreement, in writing, which agreement shall not be less favorable with respect to any term or condition of this Agreement. For greater certainty, the University and the Client represent and warrant that all relevant conditions of this Agreement will be described to and accepted by the subcontractor;
  - (b) such subcontractor shall carry and maintain in full force and effect comprehensive general liability insurance (and/or any other insurance as circumstances warrant and that a prudent person would deem necessary) which insurance policy will name the University and the Client as an additional insured;
  - (c) such subcontractor will have the necessary skills and experience to carry out the subcontract; and
  - (d) the subcontractor will have the necessary permits and licenses prior to commencing the subcontract.

#### **ARTICLE 13 – TERM & TERMINATION**

- 13.1 This Agreement shall come into effect upon the Effective Date \_\_\_\_\_, and unless earlier terminated in accordance with the terms hereof, shall terminate \_\_\_\_\_. In the event that this Agreement is funded in part by the Natural Sciences and Engineering Research Council ("NSERC"), the term of this Agreement shall, at a minimum, be equal in duration to the period of the NSERC award.
- 13.2 This Agreement may be terminated by the Client upon sixty (60) days written notice to the University.

- 13.3 This Agreement may be immediately terminated by the University upon sixty (60) days written notice to the Client if circumstances beyond the University's control preclude continuation of the Research Plan.
- 13.4 Upon termination of this Agreement by either the Client or the University, the University will be reimbursed by the Client for all costs and non-cancellable commitments incurred by the University in the performance of the Research Plan, such reimbursement not to exceed the total estimated expenses set forth in Section 3.1.
- 13.5 Termination as set forth in this Article 13 shall not relieve any of the parties of any obligations accrued under this Agreement prior to the date of termination. Each of Articles 5 (Equipment), 6 (Confidentiality), 7 (Intellectual Property), 8 (Publication), 9 (Indemnity), 14 (General Provisions), Sections 10.2 (Disclaimer), 10.3 (Limitation of Liability) and 13.4 (Reimbursement for expenses), 13.5 (Survival) shall survive termination of this Agreement.

#### ARTICLE 14 – GENERAL PROVISIONS

- 14.1 The Client shall not use the name, or any variation, adaptation, abbreviation, trademark or other, of the University, nor the name of any member of the University's staff or governors, in any publicity without the prior written approval of an authorized representative of the University. Subject to Section 14.2, the University will not use the name of the Client, or any variation, adaptation, abbreviation, trademark or other, nor the name of any employee of the Client, in any publicity without the prior written approval of the Client.
- 14.2 The University may at its own discretion provide a brief listing of this Research Plan as part of any public compendium disclosing research taking place at the University. Such disclosure may include, but is not limited to, the title of the Research Plan and the name of the Client.
- 14.3 The parties are independent parties and nothing in this Agreement shall constitute either party as the employer, principal or partner of or joint venturer with the other party. Neither party has any authority to assume or create any obligation or liability, either express or implied, on behalf of the other.
- 14.4 University of Waterloo Contact Names

**Administrative Contact:**

\_\_\_\_\_  
Senior Manager  
Contracts Research and  
Industrial Grants

**Financial Contact:**

Doreen White  
Senior Manager  
Research Finance

**Intellectual Property  
Contact:**

Director Commercialization  
WatCo

- 14.5 Notices under this Agreement shall be sent by registered mail, return receipt requested or delivered by hand, return receipt requested to the following address, as shown below, unless changed by written notice.

**University:**

\_\_\_\_\_, Senior Manager  
Contracts Research and Industrial Grants  
University of Waterloo  
Office of Research  
200 University Avenue West  
Waterloo, Ontario N2L 3G1

Phone: 519-888-4567 Ext. \_\_\_\_\_  
Fax: 519-746-7151

E-mail: \_\_\_\_\_@uwaterloo.ca

**Client :**

- 14.6 For this Agreement, neither the Client nor the University shall be liable to the other for any failure or delay in performance by circumstances beyond its control, including but not limited to, acts of God, fire, labour difficulties or governmental action.
- 14.7 Unless otherwise specified in this Agreement, this Agreement shall supersede all documents or agreements, whether written or oral, in respect of the subject matter thereof. For greater clarity, no direct or indirect separate arrangement, whether oral or written, with the Principal Investigator or other person, involving any component of the work to be performed, is permitted unless prior agreement, in writing, is given by the authorized signing authorities of the Client and the University. The Client acknowledges and agrees that the University provides no insurance coverage whatsoever to faculty members or other university persons who may provide direct or independent services relating to this Agreement.
- 14.8 The terms herein stipulated may not be modified in any way without the mutual consent of the Client and the University in writing given by their authorized signing authorities.
- 14.9 This Agreement shall not be assigned by either the Client or the University without the prior written consent of the other party, such consent not to be unreasonably withheld. The University and the Client shall not subcontract any work to be performed under this Agreement without the prior written consent of the other party (such consent not to be unreasonably withheld) except as specifically set forth in the Research Plan and in accordance with Section 12.2 of this Agreement.
- 14.10 In the event that a translation of this Agreement is prepared and signed by the Client and the University for the convenience of the Client, this English language version shall be the official version and shall govern if there is a conflict between the two.
- 14.11 This Agreement shall be governed by and construed in accordance with the laws of the Province of Ontario and the laws of Canada applicable therein.

14.12 The Parties agree that a fax signature shall be treated as if it were an original signature and neither Party shall contest the validity of this Agreement based upon the use of fax signatures.

14.13 The following appendices are attached to and form part of this Agreement:

Schedule A – Research Plan

Schedule B – Research Participant Agreement

**IN WITNESS WHEREOF** the Client and the University hereto have executed this Agreement in a legally binding manner.

) **UNIVERSITY OF WATERLOO**  
 )  
 )  
 ) Per: \_\_\_\_\_  
 ) Name:  
 ) Title:  
 ) I/We have the authority to bind the corporation  
 )  
 ) \_\_\_\_\_  
 ) Date

)  
 ) **For the Client:**  
 )  
 ) Per: \_\_\_\_\_  
 ) Name:  
 ) Title:  
 ) I/We have the authority to bind the corporation  
 )  
 ) \_\_\_\_\_  
 ) Date

**Acknowledgment and Consent of Principal Investigator**

I, having read this Agreement, hereby agree to comply with all the terms and conditions contained herein and further agree to ensure that all University Research Participants who are involved in the Research Plan are informed of their obligations under the provisions of this Agreement and have acknowledged and consented by signature of a Research Participant Agreement (Schedule B).

\_\_\_\_\_  
Name, Title

Date: \_\_\_\_\_

**SCHEDULE A**  
**RESEARCH PLAN**

## SCHEDULE B

### RESEARCH PARTICIPANT AGREEMENT

**WHEREAS** the University of Waterloo and the Client are parties to a Sponsored Research Agreement number # \_\_\_\_\_ to which this Research Participant Agreement is appended; and

**WHEREAS** the undersigned is associated with the University of Waterloo and will be involved in the Research Plan defined by the Sponsored Research Agreement;

**NOW THEREFORE**, in consideration of information and facilities made available to me in connection with my work in relation to the Research Plan and other valuable consideration, I agree that:

1. **Defined Terms.** All terms denoted with initial capital letters herein shall have the meanings ascribed to them in the Sponsored Research Agreement.
2. **Reasonable Efforts.** I will use all reasonable efforts to achieve the objectives and deliverables defined in the Article 2 of the Sponsored Research Agreement for those activities in which I am involved.
3. **Research Results** I will co-operate fully and in good faith in discussion and agreement with all conditions regarding Research Results as set forth in Article 7 of the Sponsored Research Agreement.
4. **Confidential Information.** In accordance with Article 6 of the Sponsored Research Agreement, I will keep confidential all of the Confidential Information that I may receive.
5. **Publications.** I will comply with all publication conditions that are set out in Article 8 of the Sponsored Research Agreement.
6. **Ownership.** I understand that ownership of any Research Results shall be determined in accordance with Article 7 of the Sponsored Research Agreement and the *University of Waterloo Policy #73 (Intellectual Property Rights)*.
7. **Invention Disclosure.** I shall keep the Principal Investigator fully and promptly informed on an on-going basis of the development of Research Results and shall not take any steps with respect to filing intellectual property protection for any Research Results without prior consultation with the Principal Investigator.
8. **Cooperation in Patent Matters.** I will cooperate fully in the signing of documents and taking such other steps as may be reasonably requested to obtain and maintain patent and other intellectual property protection for the Research Results relating to the Sponsored Research Agreement and in connection with any infringement action in any way relating to said Research Results, and I will sign all documents and do all things necessary or proper to give effect to this Research Participant Agreement and any rights granted by the University under the Sponsored Research Agreement.

9. **Commercialization Revenue.** I agree that allocation of the revenue from sales, royalties, licence fees or other sources received as a result of the commercialization of Research Results relating to the Sponsored Research Agreement to which I contribute as an inventor shall be made in a manner consistent with the University of Waterloo Policy #73 (Intellectual Property Rights).
10. **Acknowledgement.** I have obtained or have been afforded the opportunity to obtain independent legal advice with respect to this Research Participant Agreement and all documents and transactions related thereto and I fully understand the nature and consequences of this Research Participant Agreement and all documents and transactions related thereto.

By signing below, I indicate my acceptance of these terms.

_____ Research Participant's Signature	_____ Witness' Signature
_____ Print Name	_____ Print Name
_____ Date	_____ Date
_____ Research Participant's Signature	_____ Witness' Signature
_____ Print Name	_____ Print Name
_____ Date	_____ Date
_____ Research Participant's Signature	_____ Witness' Signature
_____ Print Name	_____ Print Name
_____ Date	_____ Date
_____ Research Participant's Signature	_____ Witness' Signature
_____ Print Name	_____ Print Name

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Date

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Date

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Research Participant's Signature

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Witness' Signature

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Print Name

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Print Name

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Research Participant's Signature

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Witness' Signature

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Print Name

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Print Name

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Date

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Date

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Research Participant's Signature

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Witness' Signature

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Print Name

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Print Name

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Date

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Date

**Appendix B: Technical Director/Research Associate Dr. Rizwan Younis CV**

## Rizwan Younis, PhD, P.Eng.

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- Education**
- PhD in Civil Engineering; University of Waterloo, Waterloo, Ontario, Canada; 2010
  - Bachelor of Mathematics (Major: Systems Management; Minor: Computer Science); University of Waterloo, Waterloo, Ontario, Canada; 2004
  - B.Sc. Civil Engineering; University of Engineering and Technology, Lahore, Pakistan; 1993
- Academic and Professional Appointments**
- Research Associate and Technical Director; Centre for Advancement of Trenchless Technologies (CATT); University of Waterloo; Nov. 2009 – To date
  - Adjunct Faculty; Department of Civil and Environmental Engineering; University of Waterloo; Sept. 2010 – Apr. 2011, Fall 2013, Spring 2017
  - Consultant; eTrenchless Group Inc., Waterloo; Jan. – Dec. 2009
  - Research Assistant; Department of Civil and Environmental Engineering, University of Waterloo; Sept. 2005 – Jul. 2010
  - Construction Engineer, Pakistan Drainage Consultants, Lahore, Pakistan; Dec. 1998 – May 1999
  - Design Engineer; Swabi SCARP Consultants, Mardan, Pakistan; May 1994 – Dec. 1998
  - Construction Engineer; Snowy Mountains Engineering Corporation, Chakwal, Pakistan; Jul 1994 – May 1995
  - Infrastructure Engineer; KAMPSAX International A/S in association with Indus Associated Consultants, Islamabad, Pakistan; Jul. 1993 – Jun. 1994
- Academic Awards**
- NSERC PGS for Doctoral Studies
  - University of Waterloo President’s Graduate Scholarship
  - University of Waterloo Graduate Merit Scholarships
  - Ontario Graduate Scholarship in Science and Technology
  - Canadian Water Network Research Award
- Research Interests**
- Materials behaviour and performance based design of buried water and wastewater infrastructure
  - Reliability analysis: statistical modeling of stochastic degradation processes (survival analysis; time-to-event data analysis; reliability models)
  - Infrastructure finance: financial planning; applications of stochastic calculus and state space methods; and alternative financing mechanism
  - New high performance materials with low carbon footprint and high corrosion resistance for renovation of existing infrastructure
- Research Awards (with PI Dr. Mark Knight)**
- Project Manager and Research Associate | Subsurface Utility Engineering – Investigation of Current Practices and Quantification of Benefits/ROI; Funding: Consortium of Municipal and Industry Organizations; Duration: 2018-2020
  - Project Manager and Research Associate | Investigation of Flexural Creep Properties for NuFlow CIPP (Cured-in-Place Pipe); Total Value: \$18,000; Duration: 2018/19

## Rizwan Younis, PhD, P.Eng.

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- Research Associate and Project Coordinator | Asset Management Readiness Assessment for Canadian Municipalities; Total Value: \$37,500; Funding Agency: Southern Ontario Water Consortium (SOWC); Duration: 2018/19
- Project Coordinator | Calculator for Reduction of GHG Emissions from Innovative Wastewater Treatment Processes and Technologies; Total Value:\$40,000; Southern Ontario Water Consortium (SOWC); Duration: 2018
- Co-Principal Investigator | Potable Water Pipeline Defect Condition Rating System; Total Value: \$541,567; Funding Agency: Water Research Foundation, USA; Duration: 2014-17
- Research Associate | Advancing Water Main Renovation and Design; Total Value \$615,000; Funding Agency: NSERC-OCE-Alberta Innovates, Alberta-Ontario Innovation Program; Duration: 2017-19
- Research Associate | Novel Water Technology for Livable Cities: Total Value: \$374,071; Funding Organizations: NSERC-OCE and Envirolomics Engineering Inc., Canada; Duration 2014-17
- Research Associate | Optimal Strategies for Sustainable Management of Drinking-Water and Wastewater Networks; Total Value: \$552,780; Funding: NSERC CRD and the cities of Cambridge, Niagara Falls and Waterloo; Duration: 2011-14
- Project Coordinator | Longevity of New Cured-In-Place (CIPP) Lining Systems for Water and Industrial Piping Networks; Total Value: \$43,000; Client: Interplastic Corporation, USA; Duration:2013-15

### **Administrative Experience** 2009 – To date

- Managed CATT's day-to-day operations and business
- Coordinated with the uWaterloo Finance, IT, Office of Research, and other departments
- Organized educational events including workshops and conferences
- Developed annual operating budgets, and hired and managed staff and students
- Managed the implementation of content management and e-commerce systems
- Worked with the CATT committees to ensure the delivery of CATT's programs and services
- Developed educational programs and partnerships with organizations, such as Fleming College and OGRA (Ontario Good Roads Association)
- Organized and participated in the strategic retreats to review and develop CATT's strategic vision and programs
- Worked with the CATT's Board of Directors and provided reports on CATT's operations/business and educational and research initiatives
- Organized and prepared presentations for the AGMs (annual general meetings) and reported on CATT's research and education programs

### **Teaching Interests**

- Buried Infrastructure Asset Management
- Trenchless Technologies
- Geotechnical Engineering
- Probability and Statistics for Engineers
- Engineering Economics

### Courses Taught

- Asset Management of Buried Infrastructure; Ontario Good Roads Association (OGRA)
- Horizontal Directional Drilling Fundamental: Design to Construction
- CIVE 354: Geotechnical Engineering II; Level: third year students in Civil Engineering and final year students in Geological and Environmental Engineering disciplines; Topics include: Foundation engineering; Earth pressure theories; Retaining walls; Anchors; Shallow and deep foundations; Braced trenches and excavations; and Slope stability
- CIVE 554: Geotechnical Engineering-III; Level: senior undergraduate and graduate students; Topics include: Simulation of geotechnical consulting practice. Students are required to complete several projects, based on actual case studies, which require problem identification, evaluation of geotechnical data, analysis, design, and report preparations
- Engineering Data Management (databases and GIS) and Analysis
- Engineering Data Analysis Methods and Tools (EDAT)

### Selected Research Projects

***Potable Water Pipeline Defect Condition Rating System***  
***Research Partners: Battelle Memorial Institute, USA, Yeda Consultants Inc., Canada***  
***Funding: \$541,367, Water Research Foundation, USA, water utilities and technology providers; Duration: 2014-17***

The development of a defect coding and condition rating system for drinking water distribution systems is proposed in the context of a comprehensive condition assessment and asset management framework. The framework will take into account the concept of criticality and will specify risk-based procedure(s) and algorithms to identify various categories of pipes or parts of network. A generic, open source data model and schema will be proposed so that defect coding and condition grading system can be readily incorporated into a database management or geographic information system (GIS). The framework will also include a decision support system to categorize pipes for various rehabilitation and replacement techniques or to carry out basic to advanced levels of investigations. The development of a standard condition rating system for water networks will allow the water utilities to manage their systems in a more cost-effective and efficient manner. The condition rating information is useful for: (1) assessing the current condition of infrastructure; (2) defining levels of service; (3) evaluating the changes in condition over time; (4) predicting future condition; (5) prioritizing maintenance, rehabilitation, and replacement activities in conjunction with criticality studies; and (6) planning and budgeting for capital projects. The condition rating system will also be used as a communication tool to inform consumers and policy makers and to define existing and future needs to meet desired levels of service.

***Optimal strategies for financially sustainable management of drinking-water and wastewater networks***  
***Funding: \$552,780, NSERC and the cities of Cambridge, Niagara Falls and Waterloo; Duration: 2011-14***

The objectives of this multidisciplinary project are to develop and integrate: (1) hydrological simulation model to quantify the interaction of groundwater with leaking water and wastewater networks; (2) strategic planning model for water and wastewater infrastructure; and (3) control and optimization model to simulate the impact of alternative management strategies. Advanced statistical techniques employing generalized linear models have been used to investigate the deterioration and failure mechanisms of water and wastewater pipelines. Using historical construction cost data from the cities of Waterloo and Niagara Falls, a new construction cost index for water and wastewater pipelines' capital projects has been proposed. The application of stochastic diffusion and state-space models has been investigated to forecast the unit cost of water and wastewater capital projects. The project contributed to the knowledgebase required to implement Ontario Ministry of the Environment's (MOE) financially sustainable drinking-water and wastewater system legislation. In particular, the project developed tools to quantify the condition and operation of buried infrastructure, surveyed and estimated current condition, developed models to forecast deterioration over time under potential future operational conditions, and estimated the present value of the infrastructure as well as inflation in the unit cost of operation, maintenance, repair, rehabilitation and replacement (OMR3) expenditures needed for PSAB (Public Sector Accounting Board) reporting. A preliminary online decision support tool that combines physical infrastructure sector with the financial and consumer sectors can be viewed at the following web link: <http://forio.com/simulate/ryounis/townofgeorgina1/simulation/>

***Novel Water mains Renewal Technology for Livable Communities***  
***Funding: \$374,071, NSERC – OCE Smart Drinking Water Distribution Systems Initiative; Duration: 2014-17***

This project will enhance the development of an innovative pipe inspection, cleaning, and lining system that will rehabilitate rusted, clogged drinking water distribution pipes efficiently and cost-effectively. The technology will enable same-day restoration of water service without costly bypass and street excavation. The project builds on the findings from an earlier investigation to develop instrumentation system for optimization of critical operational parameters of the technology.

***Investigation of the longevity of new cured-in-place-pipe (CIPP) lining systems for water, wastewater and industrial piping networks***  
***Client: Interplastic Corporation, Minneapolis, MN, USA; Funding: \$43,000; Duration: 2013-15***

High-performance composites have advanced the existing cured-in-place-pipe lining systems for trenchless rehabilitation of deteriorated water, wastewater, and industrial pipelines. The objective of this project is to investigate the performance and longevity of nine new cured-in-place-pipe (CIPP) lining systems. Mechanical behaviour of CIPP liners will be investigated for elastic, plastic and creep deformation. Finite element modeling of load transfer to CIPP will be carried out to forecast short-and long-term behaviour and collapse pressures. The project will help in building a new research

partnership with the Nanotechnology Engineering Department to investigate the use of nano-materials for renewing existing water, wastewater and industrial piping systems and to employ nano- and micro-mechanics to investigate their behaviour.

### Publications

#### Articles Published in Refereed Journals

- Younis, R., Rehan, R., Unger, A.J.A., Yu, S. and Knight, M. (2016). Forecasting the Unit Price of Water and Wastewater Pipelines Capital Works and Estimating Contractors' Markup. *Journal of Cost Analysis and Parametrics*, 9:1, 46-68. doi: 10.1080/1941658X.2016.1155187
- Rehan, R., Younis, R., Unger, A.J.A., Shapton, B., Budimir, F. and Knight, M. (2016). Development of Unit Cost Indices and Database for Water and Wastewater Pipelines Capital Works, *Journal of Cost Analysis and Parametrics*, 9:2, 127-160, DOI: 10.1080/1941658X.2016.1201023
- Younis, R., Knight, M. (2012). Development and implementation of an asset management framework for wastewater collection networks. *Tunneling and Underground Space Technology*. (NSERC, Canadian Water Network)
- Younis, R. and Knight, M. A. (2010). A continuation-ratio model for the performance behavior of wastewater collection networks. *Tunneling and Underground Space Technology*, Elsevier, 25(6), 660-669.
- Younis, R. and Knight, M. A. (2010). A probability model for investigating the trend of structural deterioration of wastewater pipelines. *Tunneling and Underground Space Technology*, Elsevier, 25(6), 670-680.

#### Contributions to a Collective work and Book Chapters

- Younis, R. (2010). Discussion on integrated decision support system for optimal renewal planning of sewer networks. *ASCE Journal of Computing in Civil Engineering*, Vol. 24, No. 5
- Younis, R., Knight, M., Holman, G. and Darrall, B. (2011). Development of a high quality condition assessment database for the City of Niagara Falls wastewater collection network. *ASCE Manual of Practice "Guidelines for Condition Assessment of Collection Systems."*

#### Papers in Refereed Conference Proceedings

- Ganjidoost, A., Younis, R., Knight, M. (2015). Water mains degradation analysis using Poisson-based Log-linear model. *ASCE Pipelines 2015 Conference*, Baltimore, MD.
- Younis, R., Knight, M., Kleiner, Y., Matthews, J., and Zhang, J. (2015). Drinking water pipelines defect coding system. *ASCE Pipelines 2015 Conference*, Baltimore, MD.
- Younis, R., Knight, M., Kleiner, Y., Matthews, J., and Zhang, J. (2015). Framework for a standard Defect coding system for potable water pipe networks.

North American Society for Trenchless Technology No-Dig Show 2015, Denver, CO.

- Younis, R., Knight, M., Kleiner, Y., Matthews, J. (2015). Developing a framework for watermains' defect coding and condition classification standard. Ontario Water Works Association 2015 Conference, Toronto, ON
- Younis, R., Knight, M., Kleiner, Y., Matthews, J. (2015). Drinking water pipelines defect coding system. American Water Works Association (AWWA) ACE 2015 conference, Anaheim, CA
- Knight, M. A., Younis, R., Johnson, D., Cooper, R., and Thorogood, B. (2015) Development of a new watermain renewal cleaning and lining technology capable of same day return to service. ACE 2015 conference, Anaheim, CA
- Knight, M., Younis, R., Darrell, B., Russin, M., and Manners, C. (2009). Advances in Pipeline Asset Management Using Digital Side Scanning Evaluation Technology. International No-Dig Show 2009 Conference Proceedings, North American Society of Trenchless Technology (NASST) & International Society for Trenchless Technology, Toronto, Ontario, Canada
- Younis, R. and Knight, M. A. (2008). An empirical model for the prediction of structural behavior of wastewater collection systems. In ASCE International Pipelines Conference 2008, Atlanta, USA
- Watt, D., Knight, M., Noble, B., Younis, R., and Hummel, B. (2006). Public private partnership brings state-of-the-art wastewater technology to the City of Niagara Falls. NASST No Dig 2006 Conference Proceedings, Nashville, USA

### Research Reports

- Younis, R., Knight, M., and Abdel-Aal, A. (2018). Phase 1 Report: Flexural and Tensile Properties of NuFlow CIPP, Client: NuFlow
- Knight, M., Younis, R., Abdel-Aal, A., Olukayode, A., and Ibrahim, S. (2016). Pilot Study: Evaluation of 3M™ Scotchkote™ Pipe Renewal Liner 2400 for Renovation of Potable Water Distribution Pipelines, Client: City of London
- Knight, M., Shapton, B., Kennigton, A., and Younis, R. (2015). Tensile Testing of 16-inch Cobra Lock® Joint System, Client: Royal Pipe Systems
- Knight, M., Shapton, B., Kennigton, A., and Younis, R. (2015). GRP Panel Shear Bond and Grout Testing, Client: AECOM
- Knight, M., Younis, R. and Shapton, B. (2015). Tensile Testing of 16-inch Cobra Lock® Joint System, Client: Royal Pipe Systems
- Knight, M., Younis, R. (2014). Miller-Coors Albany CIPP mechanical testing reports 1 and 2; Client: Evanco Environmental Technologies, Inc.
- Younis, R., Knight, M. (2013). Phase II: Impacts of sewer cleaning jets on PE gas pipes. Client: Enbridge Gas Distribution
- Younis, R., Knight, M., Mohammed, S. (2013). Watermain cleaning technology and spray-on liner evaluation – City of Cambridge watermain rehabilitation pilot project.

- Merkoukhina, K., Knight, M., Verwey, K., Younis, R. (2012). Evaluation of pitting characteristics of tube walls caused by sewer cleaning nozzles. Client: Enbridge Gas
- Younis, R., Knight, M., (2010). A review of abrasion resistance of PVC pipes. Client: Royal Pipe Systems

### **Presentations**

- Introduction to Watermain Ranking and Prioritization, AWWA ACE 2017, Philadelphia, PA
- Interactive Session on the New WRF Watermain Condition Coding Classification, AWWA ACE 2017, Philadelphia, PA
- Pilot Study for Waterless Water Main Cleaning, Condition Assessment and Pipe Lining, AWWA ACE 2016, Chicago, IL
- Water Main Condition Classification System for Managing Integrity of Water Distribution Systems, Ontario Water Works Association Water Conference and Trade Show 2016, Windsor, ON
- Framework for Potable Water Pipeline Defect Coding and Condition Rating System, American Water Works Association ACE 2015, Anaheim, CA
- Drinking Water Pipelines Defect Coding System, ASCE Pipelines 2015, Baltimore, MD
- Developing a Framework for Water main Defect Coding and Condition Classification Standard, OWWA Ontario's Water Conference and Trade Show, Toronto (2015)
- Development of a North American Drinking Water Pipelines' Defect Coding and Condition Rating Standard, Trenchless Technology Roadshow, Niagara Falls, ON. (2014)
- Will your water rates cover actual water projects' inflation costs over the next 10 to 20 years? Trenchless Technology Roadshow, Niagara Falls, ON. (2014)
- Advances in watermain cleaning and lining, Trenchless Technology Roadshow, Niagara Falls, ON. (2014)
- Pipelines' condition assessment and deterioration modelling, Advances in Water and Wastewater Infrastructure Asset Management, Niagara Falls, ON. (2014)
- Forecasting the unit cost of water and wastewater capital works, Advances in Water and Wastewater Infrastructure Asset Management, Niagara Falls, ON. (2014)
- The need for new technology benchmarking initiatives; Pilot Project: Lessons Learned; Mississauga, ON. (2013)
- Evaluation of 30 years of water and sewer projects' progress certificates to determine inflation indices; Underground Infrastructure Research International Conference and Trenchless Technology Road Show, Niagara Falls, ON. (2012)
- Quality assurance and quality control for trenchless inspection projects – the City of Niagara Falls case study. CATT/OGRA Trenchless Technologies 101 workshop, Mississauga, ON. (2012)

- Younis, R., Darrall, B., (2011). Small diameter pipe inspection – SSET for Sewer Asset Management at the City of Niagara Falls. Successful completion of wastewater pipelines condition assessment and rehabilitation construction projects. Mississauga, ON. (2011)
- Small diameter pipelines condition assessment and quality assurance quality control. CATT/OGRA (Ontario Good Roads Association) technical workshop on Introduction to Trenchless Technologies. (2011)
- Management tools for sustainable buried infrastructure, Mississauga, ON. (2010)
- Optimal strategies for the financially sustainable management of drinking-water and wastewater networks, NSERC CRD, The Regional Municipality of Waterloo, ON, Canada. (2010)
- Wastewater pipelines asset management, and optimal strategies for the financially sustainable management of drinking-water and wastewater networks, NSERC CRD, City of Niagara Falls, ON, Canada (2010)
- Pipelines deterioration models, Trenchless Road Show 2010. Mississauga, ON, Canada. (2010)
- An empirical model for the prediction of structural behavior of wastewater collection systems. ASCE International Pipelines Conference, Atlanta, GA, USA. (2008)
- Introduction to pipeline assessment and asset management. OGRA workshop on trenchless sewer and storm network location, construction, assessment and rehabilitation. Mississauga, ON, Canada. (2008)
- Inspection of small diameter pipes. OGRA workshop on trenchless sewer and storm network location, construction, assessment and rehabilitation, Mississauga, ON, Canada. (2008)
- Empirical modeling for structural health of civil infrastructure facilities. Graduate Student Research Conference. University of Waterloo, Waterloo, ON, Canada. (2008)
- You should care for water. Canadian Independent College, Baden, ON, Canada. (2007)
- Benchmarking in Southern Ontario: Development of asset management in the City of Niagara Falls, Asset Management for Water and Wastewater Systems – Underground Infrastructure Management Conference Series, Washington D.C., USA. (2006)
- Buried infrastructure asset management. Canadian Water Network Workshop on Infrastructure, The City of Niagara Falls, ON, Canada. (2006)

### Poster Presentations

- Younis, R., Knight, M. (2007). Buried infrastructure asset management. Canadian National Asset Management Workshop. Hamilton, ON, Canada
- Younis, R., Knight, M. (2006, 2007). Deterioration modeling for wastewater Pipelines. No Dig 2006 (Nashville, USA) and No Dig 2007 (San Diego, USA) Student Poster Exhibition, North American Society of Trenchless Technology. (won the first prize)

## Rizwan Younis, PhD, P.Eng.

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- Younis, R., Knight, M., and Rehan, R. (2006). Development of wastewater collection network asset database and management framework. The 3rd Canadian Water Network, Connecting Water Resources National Conference. Montreal, QC, Canada
- Software Proficiency and Computing Skills**
- Programming and Computing: Visual Basic; Visual C++; VBA; and Matlab
  - Statistics and Econometrics: R; SPSS; SAS; and Matlab
  - Computer Algebra Systems: Maple
  - Databases: SQL Server; Microsoft Access
  - GIS: ArcGIS; Manifold; QGIS
- Industry Experience**
- Team leader (research & development); eTrenchless Group Inc., Waterloo, ON. Mar. 2009 – Jun. 2009**
- Carried out horizontal directional drilled (HDD) bore path and pipeline design analysis
  - Prepared draft and final design and construction documents
- Construction Engineer (Hydraulics and Structures); Pakistan Drainage Consultants, Lahore, Pakistan; Jan. 1999 – May 1999**
- Supervised field surveys of irrigation channels, carried out inspections of hydraulic structures (falls, regulators, and cross-drainage installations), reviewed existing drawings, and determined rehabilitation and reconstruction needs
  - Participated in the evaluation and award of tenders
  - Developed quality assurance and quality control procedures based on ISO standards
- Design Engineer (Hydraulics and Structures); Swabi SCARP Consultants, Mardan, Pakistan; May 1995 – Jan 1999**
- Carried out detailed hydraulic design of water channels and allied hydraulic structures that included aqueducts, siphons, inverted siphons, drop structures, energy dissipaters, diversion works, and irrigation channels' inlets and outlets
  - Performed structural design for single-span beam and slab bridges, and sub- and super-structure for multi-span aqueducts
  - Supervised the collection of field data and surveys, and prepared construction drawings and the Engineer's estimates
- Office Engineer; Construction of Lahore-Islamabad Motorway; Snowy Mountains Engineering Corporation, Jun. 1994 – May 1995**
- Performed geometric design of flyover and subway access roads
  - Developed and verified earthwork cross-sections and estimated earthwork and pavement quantities
  - Monitored the control and construction surveys

- Verified shop drawings and bar-bending schedules for culverts and bridges
- Carried out site inspections and measurements for reinforced concrete structures and prepared weekly and monthly progress reports
- Verified the Contractors' interim payment certificates

**Junior Engineer; Development of Computer-Aided Road Maintenance Management System; Kampsax International A/S in association with the Indus Associated Consultants; Jul. 1993 – May 1994**

- Carried out pavement distress evaluations by performing road strength and roughness tests
- Developed empirical relation between bump integrator counts and pavement roughness
- carried out topographic surveys of roads and condition surveys for bridges and culvert
- Carried out data processing and analysis, and made recommendations for maintenance and rehabilitation of pavements and allied structures along with quantities and cost estimates

**Other Services**

- Reviewer for the Journal of American Water Works Association; IEEE Transactions on Engineering Management; Risk Analysis – An International Journal; and Water Research
- Member, Environmental Advisory Committee, City of Kitchener, 2012-14
- Past Member, Globe Performance Solutions Consortium Advisory Committee
- Organized the 14th International Trenchless Technology Research Colloquium, June 2012, Niagara Falls, ON, Canada
- Moderator for the Design Considerations Session at the 2012 Underground International Conference and Trenchless Technology Road Show, Niagara Falls, ON, Canada
- Moderator for the Future, Corrosion, Education and Case Studies session at the 2008 ASCE International Pipelines Conference in Atlanta, GA, USA

### References

1. Dr. Mark Knight, P.Eng.  
Associate Professor  
Department of Civil & Environmental Engineering  
University of Waterloo  
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Waterloo, ON Canada N2L 3G1  
Tel: 1(519) 581-8835  
Email: maknight@uwaterloo.ca
2. Dr. Andre Unger, P.Eng.  
Associate Professor  
Department of Earth and Environmental Sciences  
University of Waterloo  
200 University Avenue West  
Waterloo, Ontario, Canada N2L 3G1  
Tel: (519) 888-4567 ext. 37235  
Email: aunger@uwaterloo.ca
3. Dr. Giovanni Cascante, P.Eng.  
Associate Professor  
Department of Civil and Environmental Engineering  
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Tel: (519) 888-4567 ext. 32098  
Email: gcascant@uwaterloo.ca

## Appendix C: Associate Director Programs and Operations Job Description

## Job Description

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<b>Job Title:</b>	Associate Director, Programs and Operations
<b>Department:</b>	Centre for Advancement of Trenchless Technologies (CATT)
<b>Reports To:</b>	CATT Executive Director
<b>Jobs Reporting:</b>	Outreach Program Coordinator
<b>Salary Grade:</b>	USG 12
<b>Effective Date:</b>	October 2018

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### **Primary Purpose**

To provide leadership and oversight to the development and management of the Centre for the Advancement of Trenchless Technologies (CATT), which develops, delivers, and supports non-credit, professional development courses, certificates, corporate training, community outreach initiatives, and other lifelong learning opportunities beyond University credit programs, generating revenue for its operation.

The Associate Director, Programs and Operations is responsible to grow CATT's annual net revenue by expanding existing programs and services and its reputation as an industry leader nationally and internationally in the field of buried infrastructure trenchless construction, renovation, condition assessment and asset management and other areas described in its mandate. The incumbent will be responsible for the Centre's administration, education programs, conferences, branding, marketing, customer relationship management (CRM), e-commerce and web content management system, and staffing and finance.

This person will report to the Executive Director and Board of Directors and will work closely with the Technical Director/Research Associate.

### **Key Accountabilities**

#### **Strategic Planning and Support, including but not limited to:**

- Provide the Executive Director, Technical Director/Research Associate and the Board of Director with confidential and strategic advice, information and data to support decision making, with respect to finances, branding considerations, space planning etc
- Develop long-range strategies and operational plans for the Centre, and monitor and report on progress
- Increase CATT's net annual revenue by expanding existing programs and services, identifying new opportunities and membership
- Coordinate resources required to support strategic and operational plans, including space, and financial and human resources, and information technology
- Oversee strategic communications, including overall responsibility for internal communication, overseeing web content, and approval of external communications
- Develop and coordinate the production of reports on the Centre's activities, i.e., Centre's Senate Renewal Report and Annual Reports
- Attend CATT's Board of Directors meetings and report on activities and initiatives that support the implementation of the strategic plan
- Evaluate and monitor market trends - including challenges and opportunities - to develop and execute new growth initiatives

**Financial Oversight, including but not limited to:**

- Oversee the development of the Centre's annual operating budget
- Ensure that funds are available to support the Centre's operations
- Review the Centre's financial position with the Executive Director, Technical Director/Research Associate and the Board of Directors on a regular basis
- Ensure that all operating and research funds are soundly managed
- Provide financial input into the Centre's strategic plan
- Review and monitor existing key performance indicators (KPIs) and, if necessary, develop new KPIs and report on selected KPIs
- Assess the financial viability of proposed projects and make recommendations based on appropriate cost/benefit analysis

**Human Resources Administration, including but not limited to:**

- Assist the Executive Director and Technical Director/Research Associate with the recruitment, evaluation, promotion, professional development, and retention of administrative staff
- Regularly review the administrative staff structure to ensure that human resources are efficiently and effectively managed
- Oversee the day-to-day work of staff, including fostering constructive working relationships, monitoring workload and providing direction and problem-solving support
- Coach and mentor staff
- Administer the salary increase process for staff
- Ensure that personnel files, work schedules and vacation records for staff are maintained in accordance with the University policies

**Develop and Manage Brand Communications, Marketing, and Customer Relationship Management (CRM) Strategies, including but not limited to:**

- Work closely with CATT's Membership and Marketing and Public Relations Committee to develop and implement brand communication, marketing, and CRM strategies
- Liaise with CATT's Membership Committee to ensure retention and to drive membership growth in Ontario, Canada, North America and globally
- Promote CATT's education and research programs by developing content that will engage national and international customers through digital and print media, content marketing, social media, and free and paid advertisement
- Grow and expand the CATT's existing Online Trenchless Directory to be the Canadian Online Trenchless Directory
- Make the Canadian Trenchless Directory become an annual net revenue income source via selling advertising, etc.
- Review automated web analytics information and consolidate for sharing with the Executive Director, Technical Director/Research Associate and the Board of Directors
- Use information from automated web analytics tools to track and improve the Web CMS, customer engagement and retention, and CATT's programs and services
- Review and monitor existing key performance indicators and, if necessary, develop new KPIs and report on selected KPIs

**Manage Conferences, Education Programs, and Drive Growth, including but not limited to:**

- Work closely with CATT's Conference Committee to organize and grow the annual Trenchless Technology Road Shows (conferences) and other CATT events
- Attend Conference Committee meetings along with CATT team members to collaborate and to ensure that all the tasks are identified, assigned and executed in a timely manner

## Job Description



- Work closely with CATT's Education and Seminar Committees to develop, deliver and expand CATT's non-credit courses (seminars, workshops, in-house training courses), and education initiatives for municipalities, industry organizations and associations
- Conduct and/or organize regular meetings with the Education and Seminar Committees to help with the development of workshop descriptions/outlines/topics, and help to identify and contact speakers
- Coordinate the development of marketing and promotional materials for events, including management of content on websites and social media
- Manage staff and volunteers/instructors to ensure that all courses, workshops, and events are well marketed, and professionally delivered
- Manage budget, costs and revenues of conferences/events and education programs
- Coach and develop all Professional Development staff
- Review and monitor existing key performance indicators and, if necessary, develop new KPIs and report on selected KPIs
- Expand national and global education activities, i.e., using online/web tools
- Develop new certificate based programs, such as the Education Program for Civil Infrastructure Professionals (EPCIP) that can be offered nationally and globally
- Explore and obtain funding (grants, sponsorships, etc.) to expand the education program nationally and globally
- Review course/program/instructor evaluations and utilize the data to determine the impact on future continuing education programs
- Manage all tasks for the successful delivery of conferences and events (e.g., venue selection and bookings, arranging/contacting speakers and technical program development, arranging necessary equipment, etc.)

### **Administrative Leadership, including but not limited to:**

- Liaise with department, faculty, finance, information technology, Office of Research and others to ensure effective and efficient operation of the Centre
- Support and assist with the planning and execution of various special events, such as retreats, workshops, conferences, partnership workshops and courses, and non-credit courses, as necessary
- Work with the Technical Director/Research Associate to ensure the efficient and equitable use of facilities and equipment, including allocation of space
- Oversee maintenance, repairs, renovations and new construction as required
- Plan and co-ordinate moves
- In consultation with the Executive Director, authorize purchases and allocate equipment and furnishings
- Oversee the issue of keys and key fobs and ensure that adequate records are maintained
- Serve as a resource within the department for the interpretation of and ensuring adherence to UW and departmental policies, guidelines and practices

*\*All employees of the University are expected to follow University and departmental health and safety policy, procedures and work practices at all times. Employees are also responsible for the completion of all health and safety training, as assigned. Employees with staff supervision and/or management responsibilities will ensure that assigned staff abide by the above, and actively identify, assess and correct health and safety hazards, as required.*

## **Required Qualifications**

### **Education**

- Bachelor's Degree in Business Administration, Adult Education or a related discipline is required; Master's Degree is preferred

## Job Description



- Equivalent combination of education and experience will be considered
- Completion of additional courses in Engineering or a related discipline is an asset

### **Experience**

- 5 years of progressively responsible operational management experience including demonstrated experience with driving and managing growth, business management, finance, and budgets
- Significant experience with developing educational programs and services, planning and coordinating educational and industry events/conferences, and a proven track record of growing enrolment and revenue in an adult/professional education setting

### **Knowledge/Skills/Abilities**

- In-depth knowledge of best practices in Adult Education and online learning technologies
- Working knowledge of marketing, social media, web content management systems, e-commerce systems, and customer relationship management (CRM) tools
- Demonstrated ability to build and manage relationships and partnerships with internal and external stakeholders
- Demonstrated ability to develop and advance new programs and initiatives successfully
- Excellent verbal and written communication and problem solving skills
- Proven out-of-the-box thinker, independent and innovative solutions provider
- Willingness to learn

### **Nature and Scope**

- **Contacts:** This role will need to build effective communication channels and trust relationships with external employers, organizations, and partners; University academic units (including faculty members, chairs and deans), as well as staff in other departments. Internally communicates with: Finance, Procurement, IT (Information Technology), Civil and Environmental Engineering Department, Faculty of Engineering and other departments, and Office of Research. Externally communicates and collaborates with CATT Member Organizations, CATT Committees, CATT Partners (e.g., Benjamin Media Inc.), Industry Organizations (e.g., OGRA (Ontario Good Roads Association), OSWCA (Ontario Sewer and Watermain Construction Association), GTSWCA (Greater Toronto Sewer And Watermain Contractors Association), AM (Asset Management) Ontario, AMO (Association of Municipalities Ontario), OWWA/AWWA, etc.), Colleges/Universities (e.g., Fleming College) and organize and attend meetings if needed.
- **Level of Responsibility:** The position is responsible for direct supervision of others and supports the Technical Director/Research Associate and Executive Director in furthering strategic initiatives of CATT. Responsible for recruiting suitable staff to meet the needs of CATT while maintaining financial sustainability, and providing direction to staff. Overall responsibility for the Professional Development group, managing relationships with approximately 90 plus member organizations. Provides leadership, performance management, coaching and development for all Professional Development staff. This role will be responsible for helping to set goals and direction for the team. This role will advise the Executive Director and Board of Directors on policy and strategic direction.
- **Decision-Making Authority:** Responsible for the creation and execution of the strategic plan, and for all operational decisions within Professional Development. Responsible for the development and management of programs, and for managing a budget of around \$0.5 million in revenue annually. Incumbent will make and recommend decisions to further the growth of CATT, including development of new programs.
- **Physical and Sensory Demands:** Most of the work is office based. Help with carrying workshop materials (e.g., audio/visual equipment, course handouts, banners, etc.) will be needed. Frequent distractions and competing priorities.

## Job Description

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- **Working Environment:** Most of the work is office based. Meetings are generally over the phone. However, travel will be required for in-person meetings and to attend workshops and conferences. Most of the one-day workshops (8 to 10 every year) are in the GTA (Greater Toronto Area). Yearly conference venue alternate between Ontario (mostly in Niagara Falls) and British Columbia (Vancouver) and/or Alberta (Calgary or Edmonton).

## Appendix D: CATT Membership Directory 2018/19

	First Name	Last Name	Company	Mailing Address	Address Two	City	Province	Country	Postal Code
Mr.	Peter	McAllister	AECOM	Citi Plaza, 250 York Street	Suite 410	London	ON	CA	N6A 6K2
Ms.	Laura	Anderson	Akkerman	58256 266th Street		Brownsdale	MN	US	55918
Mr.	Mark	Andrews	Andrews Engineer	222 Laurier Ave E	Suite 200	Ottawa	ON	CA	K1N 6P2
Mr.	Keith	Walker	AP/M Permaform	PO Box 555		Johnston	Iowa	US	50131
Mr.	Ronnie	Flannery-Guy	Aqua-Rehab Inc.	2145 Michelin Street		Laval	QC	CA	H7L 5B8
Mr.	Bruce	Peight	Aries Industries	95 Whitmore Road, Unit 1		Vaughan	ON	CA	L4L 6E2
Mr.	Jason	Lueke	Associated Engineering	500, 9888 Jasper Ave		Edmonton	AB	CA	T5J 5C6
Mr.	Jason	Bunston	Atlas Dewatering Co.	111 Ortona Cr.		Concord	ON	CA	L4K 3M3
Mr.	Jason	Kottelenberg	AVERTEX Utility Solutions Inc.	205235 County Rd. 109		Orangeville	ON	CA	L9W 2Z3
Mr.	Lorne	Emery	Black & Veatch	50 Minthorn Blvd,	Suire 501	Markham	ON	CA	L3T 7X8
Mr.	Paul	Stringer	Canada Pipe Company ULC	1757 Burlington St E		Hamilton	ON	CA	L8N 3R5
Mr.	David	Beswick	Capital Sewer Services/CEC Mech.	389 Kenora Avenue		Hamilton	ON	CA	L8E 2W3
Mr.	Andy	Sherwin	Channeline	9470 Trans Canada Highway		Montreal	QC	CA	H4S 1R7
Mr.	Robert	Chisholm	Chisholm Fleming and Associates	317 Renfrew Drive	#301	Markham	ON	CA	L3R 9S8
Mr.	Alin	Hutu	CIMA+	5935 Airport Road, Suite 500		Mississauga	ON	CA	L4V 1W5
Ms.	Kelly	Oakley	City of Barrie	70 Collier Street, PO Box 400		Barrie	ON	CA	L4M 4T5
Mr.	Hardy	Bromberg	City of Cambridge	50 Dickson St, PO Box 669		Cambridge	ON	CA	N1R 5W8
Ms.	Kealy	Dedman	City of Guelph	59 Carden Street		Guelph	ON	CA	N1H 3A1
Mr.	Marc	Oddi	City of Hamilton	77 James Street North, Suite 320		Hamilton	ON	CA	L8R 2K3
Mr.	Jeff	Conrad	City of London	300 Dufferin Ave., 8th floor		London	ON	CA	N6A 4L9
Mr.	Bruno	Bianco	City of Peterborough	500 George Street North		Peterborough	ON	CA	K9H 3R9
Mr.	Mike	Mortimer	City of Stratford	82 Erie St	3rd Floor	Stratford	ON	CA	N5A 2M4
Ms.	Kerri	Marshall	City of Thunder Bay	111 S. Syndicate Avenue		Thunder Bay	ON	CA	P7C 5K4
Mr.	Kamran	Sarrami	City of Toronto	North York Civic Center	5100 Yonge St, 2nd Floor	Toronto	ON	CA	M2M 5V7
Mr.	John	Paterson	City of Vaughan	2800 Rutherford Rd.		Vaughan	ON	CA	L4K 2N9
Ms.	Caroline	Amyot	City of Waterloo	265 Lexington Court		Waterloo	ON	CA	N2J 4A8
Mr.	Marvin	Ingebriksen	City of Welland	60 East Main Street		Welland	ON	CA	L3B 3X4
Mr.	Phong	Nguy	City of Windsor	1531 Crawford Ave		Windsor	ON	CA	N8X 2A9
Mr.	Warren	Waugh	City of Woodstock	P.O. Box 1539, 500 Dundas Street		Woodstock	ON	CA	N4S 0A7
Mr.	Moaz	Ahmad	Cole Engineering	70 Valleywood Drive		Markham	ON	CA	L3R 4T5
Mr.	Jason	Spencer	Con Cast Pipe	299 Brock Road South		Pusluch	ON	CA	N1H 6H9
Mr.	Wally	Billing	Contour Directional Drilling Ltd.	374 Arthur St. S		Elmira	ON	CA	N3B 2P4
Mr.	Cal	Reaume	Cortix	7065 Auburn Road, Unit A		Milton	ON	CA	L9T 7V9
Ms.	Tracy	Watson	CRS Tunnelling Inc.	1151 South Service Rd, W. Unit #3		Oakville	ON	CA	L6L 6K4
Mr.	Larry	Corkill	CUES Canada	2-1675 Sismet Rd.		Mississauga	ON	CA	L4W 1P9
Mr.	David	Archer	DECAST Inc.	8807 Simcoe Road, Unit 56		Utopia	ON	CA	L0M 1T0
Mr.	Alex	Wagenaar	Di-Corp	8750 53 Ave NW		Edmonton	AB	CA	T6E 5G2
Mr.	Jason	Johnson	Dillon Consulting Limited	130 Dufferin Avenue Suite 1400		London	ON	CA	N6A 5R2
Mr.	John	Currey	Earth Boring Co. Limited	1576 Ifield Road		Mississauga	ON	CA	L5H 3W1
Mr.	Stewart	Day	Echologics Engineering	6295 Northam Drive, Unit1		Mississauga	ON	CA	L4V 1W8
Mr.	Stephen	Mercer	Empipe Solutions Inc.	230 Highway 20		Hannon	ON	CA	L0R 1P0
Mr.	Jay	Vanderhorst	Enbridge Gas Distribution	500 Consumers Rd		North York	ON	CA	M2J 1P8
Mr.	Brian	Thorogood	Envirologics Engineering	5-193 Manitoba Street		Bracebridge	ON	CA	P1L 1S3
Mr.	Shaun	McKaigue	Fer-Pal Infrastructure	171 Fenmar Drive		North York	ON	CA	M9L 1M7
Mr.	Edwin	Kling	Forterra	RR # 2 2099 Roseville Road		Cambridge	ON	CA	N1R 5S3
Mr.	Brad	Marin	GHD	651 Colby Drive		Waterloo	ON	CA	N2V 1C2
Mr.	Steve	Conway	GM Blue Plan Engineering	650 Woodlawn Rd W		Guelph	ON	CA	N1K 1B8
Mr.	Randy	Reimer	Hamilton Kent	77 Carlingview Drive		Toronto	ON	CA	M9W 5E6
Mr.	Andy	Braithwaite	HammerHead	775 Listowel Line		Ennismore	ON	CA	K0L 1T0
Mr.	Vince	Paparozi	HOBAS Pipe	1413 E.Richey Road		Houston	TX	US	77073
Ms.	Juliana	Arcese	IBI Group	101-410 Albert St		Waterloo	ON	CA	N2L 3V3
Mr.	Tom	Panak	InnServices Utilities Inc.	7251 Yonge St		Innisfil	ON	CA	L9S 0J3
Mr.	Ken	Foster	Insituform Technologies	3 Burford Road		Hamilton	ON	CA	L8E 3C6
Mr.	John	Bowles	Inversa Systems	711 Woodstock Road, Unit B		Fredericton	NB	CA	E3B 5N8
Mr.	Alex	Sandovski	IPEX Incorporated	6810 Invader Crescent		Mississauga	ON	CA	L5T 2B6
Mr.	Stefan	Truempt	Jack Control AG	Buchholzstrasse 50		Glarus	GL	SUI	8750
Mr.	Kim	Lewis	Liqui-Force Services Inc.	2015 Spinks Drive, RR 2		Kingsville	ON	CA	N9Y 2E5
Mr.	Jeff	Fisk	McGillivray Trenchless	3000 Ament Line		St Jacobs	ON	CA	N0B 2N0
Mr.	Michael	Ireland	Michels Canada Co	1102 16th Ave		Nisku	AB	CA	T9E 0A9
Ms.	Dot	Roga	MTE Consultants Inc.	520 Bingham's Centre Drive		Kitchener	ON	CA	N2B 3X9
Mr.	Kevin	Vine	MultiVIEW Locates Inc.	325 Matheson Blvd E		Mississauga	ON	CA	L4Z 1X8
Mr.	Derrick	Mularchuk	Municipal Sewer Services Inc.	397 Frankcom Street		Ajax	ON	CA	L1S 1R4
Mr.	Sebastian	Pelaia	New Tide Construction Ltd.	276 Glencairn Ave		Toronto	ON	CA	M5N 1T9
Mr.	Doug	Walton	Oakville Enterprises Corp	861 Redwood Square, PO Box 1900		Oakville	ON	CA	L6K 0C7
Mr.	Barry	Wood	Ontario Excavac	550 Bowes Rd		Vaughan	ON	CA	L4K 1K2
Mr.	Tony	Araujo	Paragon Systems Testing	18 Basaltic Rd		Concord	ON	CA	L4K 1G6
Mr.	Gord	Butson	R.B. Somerville Co. Limited	13176 Dufferin Street		King City	ON	CA	L7B 1K5
Mr.	Jordan	Phillips	R.J. Burnside & Associates	15 Townline		Orangeville	ON	CA	L9W 3R4
Mr.	Ragu	Nathan	RA Engineering Inc.	117 Usherwood Street		Aurora	ON	CA	L4G 7X6
Mr.	Peter	Knight-Chevalier	Rain Drain	904 Concession 2 RR # 1		Scotland	ON	CA	N0E 1R0
Mr.	Andreas	Fleischmann	RaedLinger Primus Line	Kammerdorfer Str. 16		Cham	Bavaria	CA	93413
Mr.	Mark	Bajor	Regional Municipality of Halton	1151 Bronte Road		Oakville	ON	CA	L6M 3L1
Ms.	Michelle	Moore	Regional Municipality of Niagara	3501 Schmon Parkway, Box 1042		Thorold	ON	CA	L2V 4T7
Mr.	Simon	Hopton	Regional Municipality of Peel	10 Peel Centre Drive, Suite B, 4th Floor		Brampton	ON	CA	L6T 4P9
Mr.	Vincent	Gianet	Roy Consultants	548 King Avenue		Bathurst	NB	CA	E2A 1P7
Mr.	Blair	Seeley	SCS Consulting Group Ltd	30 Centurian Drive, Suite 100		Markham	ON	CA	L3R 8B8
Mr.	Brad	Frizzell	Stantec Consulting	300 W - 675 Cochrane Dr		Markham	ON	CA	L3R 0B8
Mr.	Lawrence	Arcand	T2 Utility Engineers	1615 Dundas St., E		Whitby	ON	CA	L1N 2L1
Mr.	Jay	Scheetz	The Insurance Market	1935 Silicone Dr.		Pickering	ON	CA	L1W 3V7
Mr.	Peter	Dafoe	Town of Greater Napanee	45 Commercial Court		Napanee	ON	CA	K7R 4A2
Ms.	Vanna	You	Town of Lincoln	4800 South Service Road		Beamsville	ON	CA	L0R 1B1
Ms.	Ellen	deGuerre	Town of Richmond Hill	225 East Beaver Creek Road		Richmond Hill	ON	CA	L4B 3P4
Mr.	John	Den Hoed	Township of Centre Wellington	1 MacDonald Square		Elora	ON	CA	N0B 1S0
Mr.	Jared	Puppe	Township of Woolwich	24 Church St W		Elmira	ON	CA	N3B 2Z6
Mr.	Chris	Phippen	Utilities Kingston	85 Lappan's Lane		Kingston	ON	CA	K7L 4X7
Mr.	Garth	Fallis	Vector Construction/Corrosion	474 Dovercourt Dr		Winnipeg	MB	CA	R3Y 1A8
Mr.	Robert	Dalgleish	Vermeer Canada Inc.	10 Indell Lane		Brampton	ON	CA	L6T 3Y3
Mr.	Ken	Auty	Wallace Construction Specialties I	825 Mackay St		Regina	SK	CA	S4N 2S3
Ms.	Jenna	VanVeen	Wessuc Inc.	1693 Colborne St E		Brantford	ON	CA	N3T 5L4

## Appendix E: 2013 to 2018 CATT workshop and Seminars

No.	Event	Date	# attendees
1	TT 101 2012/OGRA	Feb 8-9, 2012	41
2	TT 101/Pre-Event	June 4, 2012	25
3	Trenchless Roadshow	June 5-6 2012	367
4	Asset Management Post Event	June 7, 2012	31
5	Maintaining Manhole Integrity: Assessment and Renewal Technologies	June 7, 2012	59
6	Engineering Successful Trenchless Projects	June 7, 2012	44
7	AGM: Bernie Krzys	June 7, 2012	44
8	CIPP Design, Construction and Quality Assurance	June 7, 2012	19
9	HDD Pipeline Construction	June 7, 2012	20
10	Pilot Projects - Lessons Learned	June 7, 2012	49
11	OGRA TT 101	June 7, 2012	49
12	Enbridge in-house HDD	June 7, 2012	15
13	Microtunneling/Baseline Reports	June 7, 2012	73
14	Advances in Watermain Renewal and Protection	June 7, 2012	72
15	Peel Region-Microtunnelling	June 7, 2012	25
16	Geotechnical Workshop-GeoMontreal	June 7, 2012	0
17	Advances in Utility Mapping	June 7, 2012	36
18	AGM	October 23, 2013	40
19	OGRA Asset Management	22-27-Nov-13	10
20	CIPP Design, Construction and Quality Assurance	November 14, 2013	25
21	HDD Pipeline Construction	November 21, 2013	28
22	Microtunneling Intro	February 6, 2014	56
23	TT 101/OGRA	4-5-Feb-14	52
24	Risk Management for TT Projects	February 20, 2014	31
25	TT 101: TRS Pre-event	May 27, 2014	31
26	Asset Management Pre Event	May 27, 2014	25
27	TRS 2014	28-29-May-14	431
28	Rehabilitation of Laterals and Water Services	September 24, 2014	60
29	Trenchless for Transit	October 15, 2014	50
30	AGM 2014	October 23, 2014	40
31	OGRA Asset Management Buried Infrastructure		9
32	Ensuring Successful Horizontal Directional Drilling	November 20, 2014	13
33	Cleaning, By-Pass and Same Day Return to Service	January 28, 2015	29
34	OGRA Trenchless Technologies 101	4, 5-Feb-15	34
35	Trenchless Technologies for Forcemain Condition Assessment	February 18, 2015	35
36	Microtunnelling for Trenchless Construction Projects	February 19, 2015	51
37	Renewing Water and Wastewater Pipelines using Cured-In Place Pipe Linings	March 4, 2015	21
38	Leak Detection Technologies	March 26, 2015	36
39	Ensuring Successful Horizontal Directional Drilling	April 22, 2015	19
40	Markham in-house training	June 23, 2015	15
41	City of Toronto in-house training	September 16, 2015	33
42	City of Toronto in-house training	October 1, 2015	33
43	Markham in-house training	October 6, 2015	15
44	City of Toronto in-house training	October 7, 2015	33
45	AGM 2015	October 22, 2015	53
46	City of Toronto in-house training	October 28, 2015	33
47	Condition Assessment and Rehabilitation of Culverts	November 5, 2015	43
48	Markham in-house training	November 5, 2015	15
49	Role and Importance of Geotechnical Engineer in Trenchless Projects	November 10, 2015	58
50	TRS BC	17-19-Nov-15	273
51	Asset mgt with OGRA	21/25-Nov-15	15
52	2-Day Watermain	26/27-Jan-16	17
53	OGRA TT 101	2-3-Mar-16	23
54	Microtunnelling for Trenchless Construction Projects	February 2, 2016	42
55	MMM Group In-house training	Feb 17 & 22	30
56	Pipe Materials for Watermains and Sewers	February 23, 2016	35
57	TRS 2016	May 18-19, 2016	480
58	TT 101 Pre-event	May 17-16	29
59	TRS 2016 Watermain Condition Classification and Renewal	May 17-16	26
60	Construction Risk Mitigation when using Trenchless Technologies	Sep-14-2016	38
61	AGM 2016	October 13, 2016	83
62	Rehabilitation Methods for Manhole Chambers	November 2, 2016	33
63	OGRA Asset mgt	21-25-Nov-2016	6
64	Condition Assessment & Rehab of Asbestos Cement Pipelines	January 24, 2017	21
65	In-house Enbridge training	February 1, 2017	20
66	Watermain Defect Coding, Condition Grading and Renovation	February 9, 2017	18
67	OGRA TT 101	23/24-Feb-17	51
68	Microtunnelling for Municipal Construction	February 16, 2017	37
69	Assessment and Rehabilitation of Transmission Mains Sewers	September 12, 2017	47
70	TRS BC 2017	25/27-Sep-2017	287
71	AGM/Chris Macey	October 11, 2017	80
72	Geotechnical Investigations	October 17, 2017	40
73	In-House Enbridge	November 1, 2017	21
74	Asset Management of Buried Infrastructure/OGRA	20-24-Nov-2017	11

75	Providing High Quality Contracts	November 28, 2017	40
76	Integrating TT into Open Cut Projects	January 23, 2018	20
77	TT 101/OGRA	30/31-Jan-18	18
78	State-of-Practice Review of Infrastructure Asset Management Systems	February 7, 2018	44
79	Microtunnelling	February 20, 2018	31
80	In-house: Enbridge Ottawa	February 27, 2018	21
81	Return on Investment for Condition Assessment Programs	March 7, 2018	34
82	TT 101 Pre - event TRS 2018:	May 15, 2018	36
83	Pressure Pipe - pre-event TRS 2018	May 15, 2018	28
84	Lateral Sewer- pre-event	May 15, 2018	25
85	SUE- pre event	May 15, 2018	12
86	Trenchless Technology Road Show 2018	16/17-May-2018	454
87	Fleming College HDD course	25/28-Jun-2018	11
88	Reducing the Costs of I & I using Trenchless Approaches	September 12, 2018	35
89	Enbridge in-house HDD	September 17, 2018	9
90	Geotechnical Investigations and Considerations for Successful Trenchless Projects	September 20, 2018	35
91	2018 AGM	October 11, 2018	79
	<b>Total Trained Industry Professionals</b>		<b>5121</b>

## Appendix F: CATT 2017/18 Year End Financial Statement

**CATT INCOME AND EXPENDITURE 2017/18  
FINANCIAL POSITION AS AT APRIL 2018**

	<b>Budget 2017-18 \$</b>	<b>Actuals May to Apr 2018 \$</b>	<b>Variance 2017-18 \$</b>
<b>INCOME</b>			
Seminars & Workshops	109,000	102,993	(6,007)
Seminars & Workshops Sponsorships	6,500	12,350	5,850
Membership Fees	120,000	117,854	(2,146)
Revenue Non Credit Courses		12,832	12,832
Roadshow Sponsorships	9,150	23,500	14,350
Roadshow Registration	187,000	147,260	(39,740)
EPCIP Training Program	10,000		(10,000)
Misc Income		755	755
Contracts Income		10,500	10,500
<b>Total Income</b>	<b>441,650</b>	<b>428,044</b>	<b>(13,607)</b>
<b>EXPENDITURE</b>			
Salaries & Benefits	175,000	184,749	(9,749)
Grad students	25,000	20,034	4,966
Consulting/Contracted Services (website)	25,000	1,733	23,267
Computer Software	1,000	1,997	(997)
Catering/Entertainment	6,000	7,795	(1,795)
Membership Fees	1,500	1,498	2
Miscellaneous	2,000	6,347	(4,347)
Credit Card Charges	3,000	4,160	(1,160)
Postage/Mailing	200	352	(152)
Printing	2,000	3,911	(1,911)
Promotion & Advertising	3,000		3,000
Supplies	4,000	3,072	928
Telephone/Fax	5,000	4,995	5
Travel	10,000	27,093	(17,093)
Computer Hardware/laptops	5,000	4,686	314
Seminar/workshop catering	12,000	14,616	(2,616)
Seminar/workshop Printing	6,000	5,095	905
Seminar/workshop promotion & advertising	1,500	620	880
Seminar/workshop supplies	1,500	1,240	260
Seminar/workshop misc	1,500	328	1,172
Seminar/Workshop Travel	1,500	10,260	(8,760)
EPCIP Travel	1,000		1,000
EPCIP Printing	500		500
Roadshow rental/lease	19,170	25,000	(5,830)
Roadshow Entertainment	37,556	39,274	(1,718)
Roadshow promotion/advertising	7,755	2,046	5,708
Roadshow supplies	9,902	1,972	7,930
Roadshow Travel	6,650	3,393	3,257
Roadshow Misc	1,750	9,723	(7,973)
Roadshow Profit Share to partners	50,600	41,958	8,642
Board Retreat	5,000		5,000
<b>Total Expenditure</b>	<b>431,583</b>	<b>427,948</b>	<b>3,635</b>
<b>Adjustments</b>			
Bad Debt Write Off	10,067	7,000	3,067
Resolution of Research Accounts		5,433	(5,433)
<b>Total Adjustments</b>	<b>10,067</b>	<b>12,433</b>	<b>(2,366)</b>
<b>Surplus (+ve)/Deficit (-ve) for Year</b>	<b>0</b>	<b>(12,337)</b>	<b>(12,337)</b>
Cumulative Surplus to Apr'17	266,825	266,825	0
<b>Surplus (+ve)/Deficit (-ve) to April'18</b>	<b>266,825</b>	<b>254,488</b>	<b>(12,337)</b>

## CATT CUMMULATIVE ROADSHOW BUDGET 2017-18

BC Roadshow Fall 2017 and London Roadshow May 2018	Budget 2017-18 \$		Actuals to Apr 2018 \$	Variance \$
<b>INCOME</b>				
Roadshow Sponsorships	1,500		23,500	22,000
Roadshow Registration	186,550		147,260	(39,290)
<b>Total Income</b>	<b>188,050</b>		<b>170,760</b>	<b>(17,290)</b>
<b>EXPENDITURE</b>				
Roadshow rental/lease	19,170		25,000	(5,830)
Roadshow entertainment	37,556		39,274	(1,718)
Roadshow promotion/advertising/printing	7,755		2,046	5,708
Roadshow supplies	9,902		1,972	7,930
Roadshow Travel	6,648		3,393	3,255
Roadshow Misc	1,750		9,723	(7,973)
Roadshow Misc - revenue sharing	50,627		41,958	8,669
<b>Total Expenditure</b>	<b>133,408</b>		<b>123,367</b>	<b>10,041</b>
<b>Surplus (+ve)/Deficit (-ve) for Year</b>	<b>54,642</b>		<b>47,394</b>	<b>(7,249)</b>

## CATT SEMINAR BUDGET 2017-18

<b>CATT SEMINARS</b>	<b>Budget 2017-18 \$</b>		<b>Actuals to Apr 2018 \$</b>	<b>Variance \$</b>
<b>INCOME</b>				
Seminars & Workshops	109,000		101,343	(7,657)
Seminars & Workshops Sponsorships	6,500		12,350	5,850
Revenue Non Credit Courses			9,292	9,292
<b>Total Income</b>	<b>115,500</b>		<b>122,984</b>	<b>7,484</b>
<b>EXPENDITURE</b>				
Credit Card Charges	3,000		4,160	(1,160)
Seminar/workshop catering	12,000		14,616	(2,616)
Seminar/workshop Printing	6,000		5,095	905
Seminar/workshop promotion & advertising	1,500		620	880
Seminar/workshop supplies	1,500		1,240	260
Seminar/workshop misc	1,500		328	1,172
Seminar/Workshop Travel	1,500		10,260	(8,760)
<b>Total Expenditure</b>	<b>27,000</b>		<b>36,319</b>	<b>(9,319)</b>
<b>Surplus (+ve)/Deficit (-ve) for Year</b>	<b>88,500</b>		<b>86,666</b>	<b>(1,834)</b>

## Appendix G: CATT 2017 Retreat SWOT Analysis and Strategic Plan

# CATT RETREAT 2017

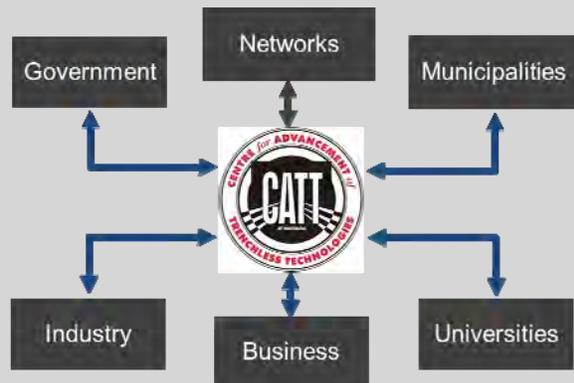
December 1, 2017

Inn on the Twenty  
3836 Main Street  
Jordon, ON



## CATT MISSION

To help municipalities and industry solve and manage their underground infrastructure challenges through research, education, technology transfer, and training of highly qualified personnel.



December 1, 2017

<p style="text-align: center;">CATT MANDATE</p> <hr/> <p style="text-align: center;"><b>To serve its members and public by addressing critical issues facing underground infrastructure installation, assessment, repair, renewal, and management.</b></p> <hr/>	<p style="text-align: center;">Over 90 Member Organizations <small>(national/multinational firms   municipalities   manufacturers)</small></p> <p style="text-align: center;">Extensive Research and Development Program <small>(asset management   infrastructure finance   trenchless renewal)</small></p> <p style="text-align: center;">Comprehensive Education, Training and Trenchless Technology Advancement Initiatives <small>(largest trenchless technology conference in Canada   epCIP   workshops   custom training courses   HDD field school)</small></p> <p style="text-align: center;"><a href="http://www.catt.ca">www.catt.ca</a></p>
--	--

<p style="text-align: center;">Retreat Goals</p> <ul style="list-style-type: none"> <li>▪ <b>Get everyone moving the CATT bus in a common direction</b></li> <li>▪ <b>Look at the past and present to see how we are doing</b></li> <li>▪ <b>Set/update policies for the next five years 2018-2023</b></li> </ul>	
<p style="font-size: small;">December 1, 2017</p> 	

## Agenda

1. **CATT's Overall Financial Position**
2. **Review of 2018 Target Items from 2014 Strategy Session**
  - a) What were the target items and where are we
3. **CATT's SWOT Analysis**
4. **New CATT Initiatives or Action Items for:**
  - a) 2017/2018 Board Term
  - b) Longer Term (2018-23)
5. **Other Business**
  - a) Senate Report
  - b) Succession Planning
  - c) Staffing

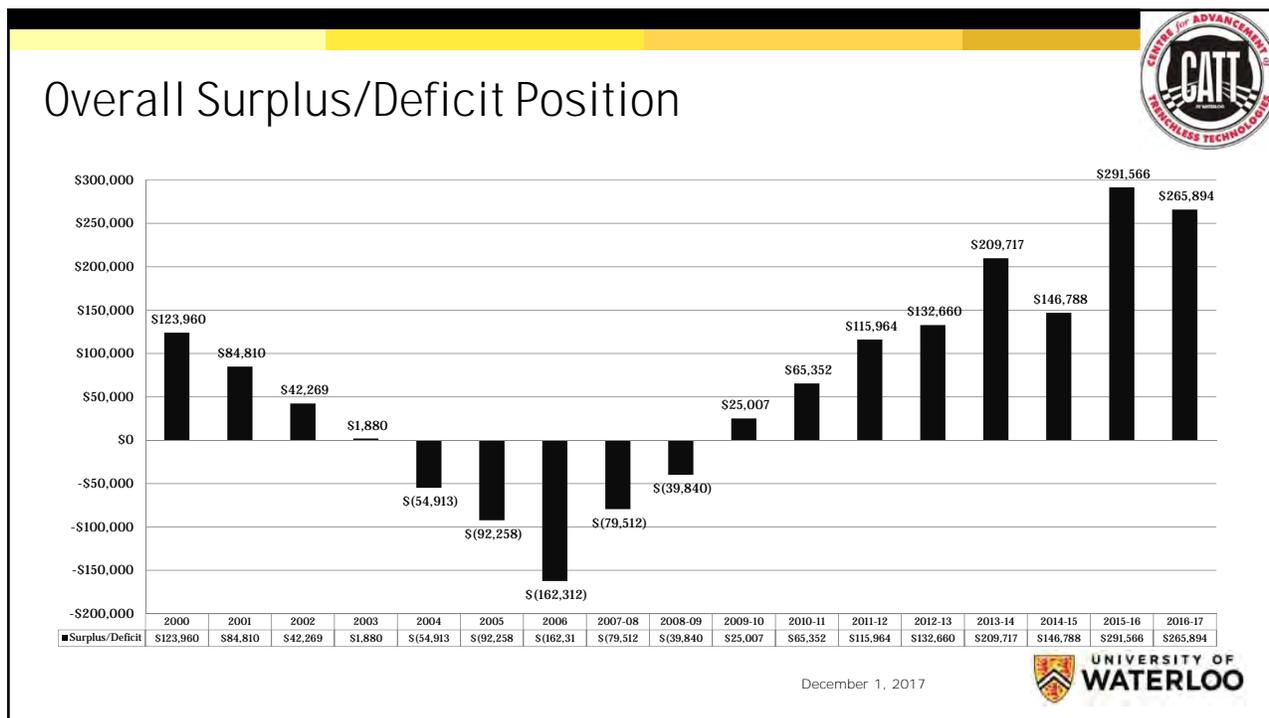
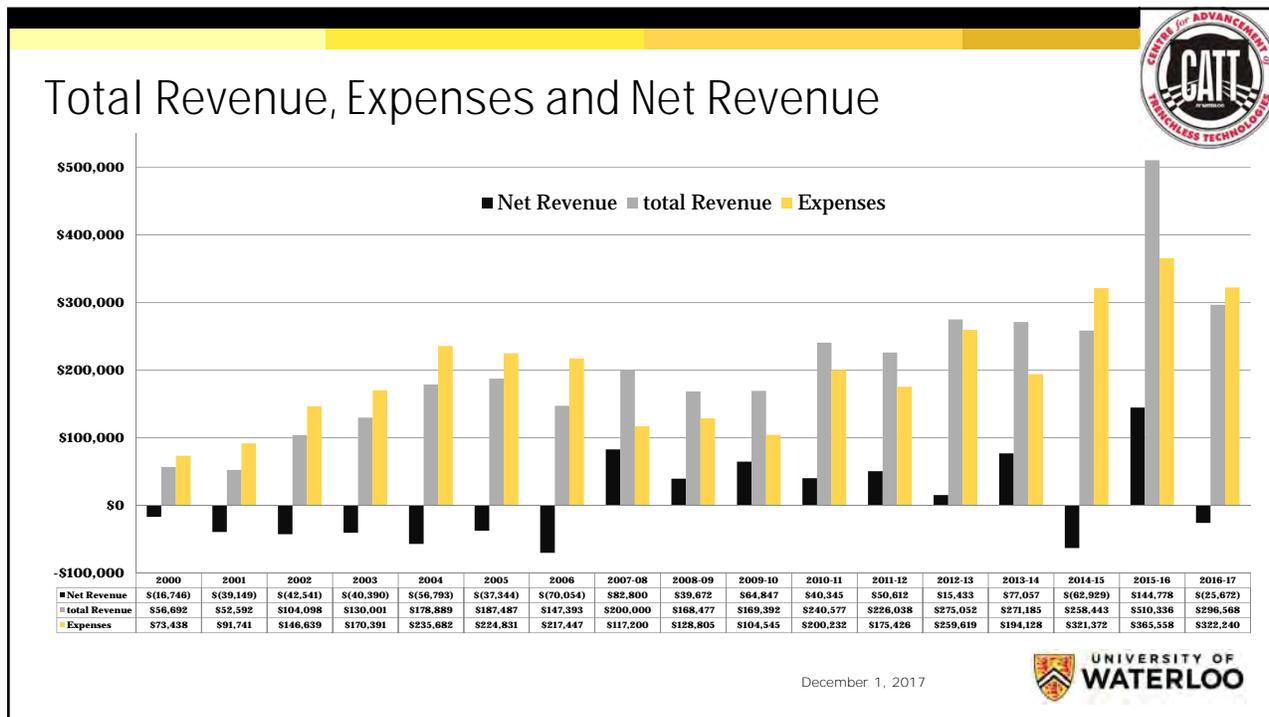
December 1, 2017

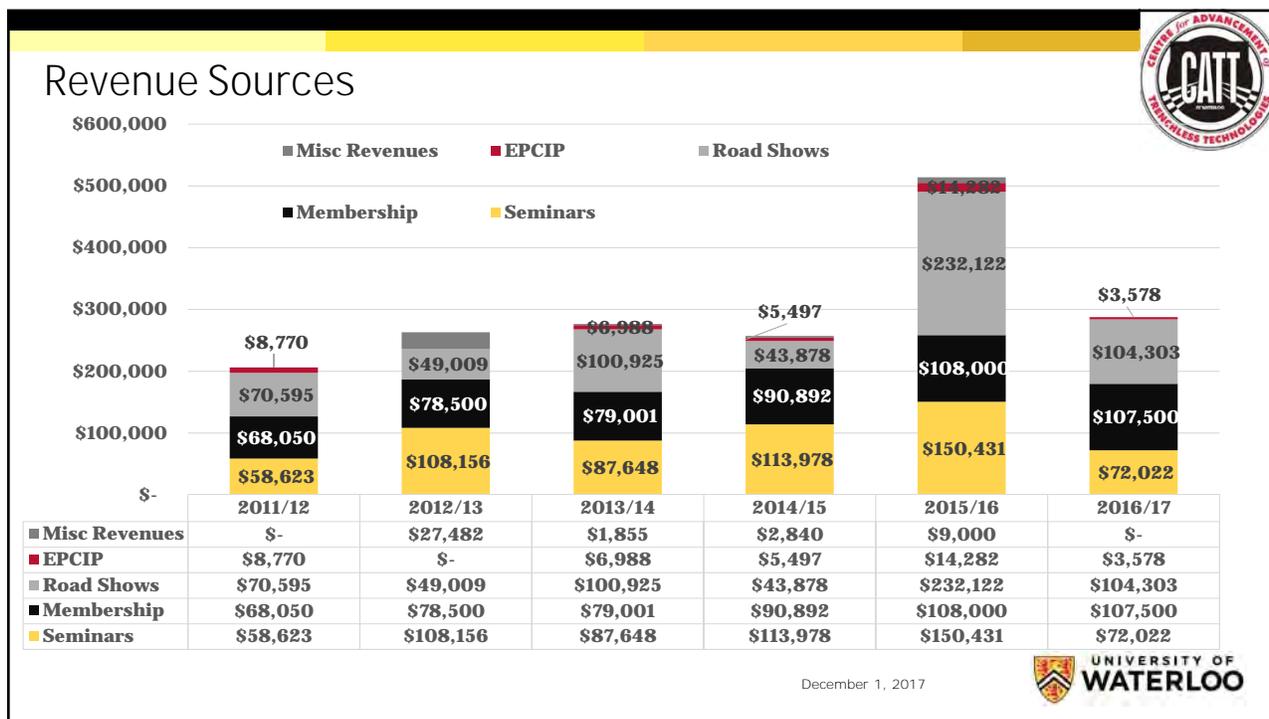


## CATT's Overall Financial Position

December 1, 2017







## Review 2018 Target Items from 2014 Strategy Session

What were the target items and where are we?

December 1, 2017

## In 2018 CATT will:

1. **Have full time managing director**
2. **Offer EPCIP all eight courses and have full time staff to support**
3. Review market/start development of best practices
4. **Develop and start Ontario Trenchless Directory**
5. **Develop annual trenchless market survey**
6. **Increase CATT industry profile with provincial/Federal government**
7. **Establish Marketing Committee with chair on BOD**
8. **Expand research and HQP by 50 percent**
9. **Increase activity by other researchers**
10. Promote development of municipal Water Infrastructure Fund
11. **Third party evaluator for Water/wastewater infrastructure technologies through ETV**
12. **Increase use of social media and web technologies**
13. **Increase seminar/workshop revenue by 50**
14. **Membership will increase from 60 to 90**
15. **Increase Trenchless Roadshow net revenue from 40 to 80**

December 1, 2017



## In 2018 CATT will:

### 1. **Have full time managing director**

#### **Managing Director Responsibilities**

- Selected and appointed by the CATT Board
- Be remunerated on a contract basis and will be reimbursed approved expenses
- Maintain and coordinate CATT's day to day activities
- Implement the initiatives and policies adopted by the Board
- Provide general monitoring and financial control
- Be responsible for oversight and support of CATT's committee activities
- Administer and assist with research contracts
- Prepare CATT's technology transfer publications
- Promote CATT's activities and membership benefits

#### **Status**

Rizwan has assumed the duties and providing support to accomplish the managing director's tasks

December 1, 2017



In 2018 CATT will:

**2. Offer EPCIP all eight courses and have full time staff to support**

Material for all the courses but one (contract administration and construction supervision) is available

**Custom Courses  
(on-site delivery)**

- **Examples**
  - City of Toronto (Trenchless Rehabilitation, Design Methods) – 4 days
  - City of Markham (Trenchless Rehabilitation, Trenchless Construction) – 3 one-day sessions
    - Director Approved Continuing Education (CE) Units by the Manager of Certification, Ministry of the Environment and Climate Change
  - MMM Consultants (Trenchless Rehabilitation Design and Construction) – 2 days
  - Enbridge Gas – 2 one-day sessions

December 1, 2017



In 2018 CATT will:

**2. Offer EPCIP all eight courses and have full time staff to support**

**Education and  
Training  
Partnerships**

- **OGRA (since 2013): Asset Management of Buried Infrastructure**
- **Fleming College (started in 2017): Horizontal Directional Drilling**
  - Director Approved Continuing Education (CE) Units by the Manager of Certification, Ministry of the Environment and Climate Change
- **OSWCA and GTSWC (recently formed partnership)**
  - 4 workshops approved for CCA's Gold Seal Certification)

OSWCA: Ontario Sewer and Water Main Construction Association  
GTSWCA: Greater Toronto Sewer and Water Main Construction Association  
CCA: Canadian Construction Association

December 1, 2017



In 2018 CATT will:

**2. Offer EPCIP all eight courses and have full time staff to support**

**Industry  
Recognized  
Certifications**

- Director Approved Continuing Education (CE) Units by the Manager of Certification, Ministry of the Environment and Climate Change
- Canadian Construction Association's Gold Seal Certification

***Need full time staff to support education program and workshops***

December 1, 2017



In 2018 CATT will:

**3. Review market/start development of best practices**

**Action**

Engaged June MacDonald, a marketing consultant, and received best practice recommendations

**Recent Update**

- Hired Nida Rafiq, a uWaterloo Global Business and Digital Arts student, to work part time for implementing selected recommendations
- Nida will start working full time in May 2018 as CATT intern to continue to design and develop CATT brochures and other materials

December 1, 2017

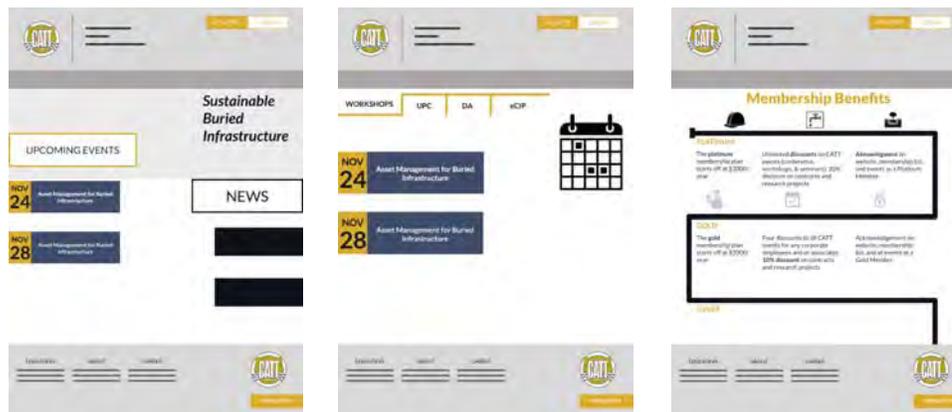


In 2018 CATT will:

**3. Review market/start development of best practices**

**Recent Update**

Updating CATT brochures, web interface, etc.



December 1, 2017

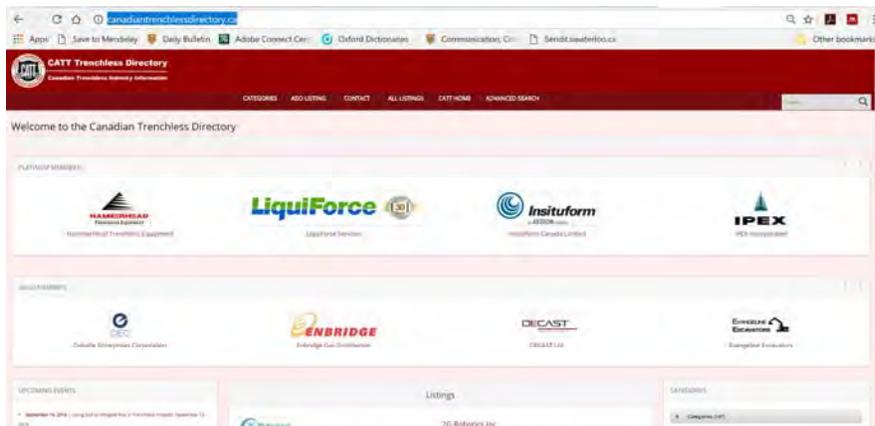


In 2018 CATT will:

**4. Develop and start Ontario Trenchless Directory**

**Future Actions**

- Update the directory
- Free vs. Paid?
- Who will maintain, update and promote the directory?



December 1, 2017



In 2018 CATT will:

**5. Develop annual trenchless market survey**



**Update**

Started the annual municipal infrastructure survey. Report is done biennially.

December 1, 2017



In 2018 CATT will:

**5. Increase CATT industry profile with provincial/Federal government**



**Update**

- Have had meetings with the federal parliamentary secretary arranged by John Green
- Organized and participated in events with the industry, e.g., AWWA, OGRA, CCGA, ORCGA, etc.
- Participation with the AWWA committees – Mark Vice Chair AWWA Watermain Rehab...
- Participated in ONEIA (Ontario Environmental Industry Association) event and maintained ONEIA membership

Need to develop strategy and plan for the future

- What should be done?
- Who will lead it?

December 1, 2017



In 2018 CATT will:

**6. Establish Marketing Committee with chair on BOD**



**Update**

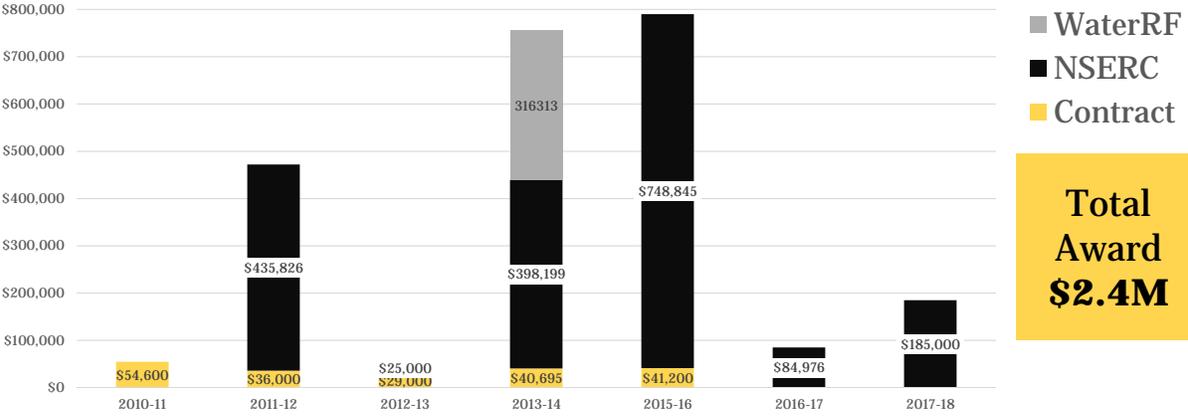
Updated the Membership Chair to Membership and Marketing Chair

December 1, 2017 

In 2018 CATT will:

**7. Expand research and HQP by 50 percent**





Fiscal Year	Contract	NSERC	WaterRF	Total
2010-11	\$54,600			\$54,600
2011-12	\$36,000	\$435,826		\$471,826
2012-13	\$25,000	\$29,000		\$54,000
2013-14	\$40,695	\$398,199	\$316,313	\$755,207
2015-16	\$41,200	\$748,845		\$790,045
2016-17		\$84,976		\$84,976
2017-18		\$185,000		\$185,000

December 1, 2017 

In 2018 CATT will:

### 7. Expand research and HQP by 50 percent

2013/14	2014/15	2015/16	2016/17	2017/18
Amin Ganjidoost	Amin Ganjidoost	Hadi Ganjidoost	Hadi Ganjidoost	Hadi Ganjidoost
Amir Riahi	Amir Riahi	Hamed Fardi	Hamed Fardi	Hamed Fardi
Hadi Ganjidoost	Hadi Ganjidoost	Tyler Gallant	Brandon Shapton	Sevda Payganeh
	Hamed Fardi	Brandon Shapton	Sevda Payganeh	Kay Awe
	Tyler Gallant	Sevda Payganeh	Kay Awe	Saad Ibrahim
	Jai Jung (Post Doc)	Kay Awe	Saad Ibrahim	Ahmed Abdel-aal
			Michael McKinnon/Johnson	Megh Suthar
			Alison Zilstra/Johnson student	
			Farid Samara	
			Ahmed Abdel-aal	

Numerous co-op, URAs, and work study students

Summary of various types of publications

December 1, 2017



#### Status

1. Amir R. (graduated)
2. Kyle V. (graduated)
3. Amin G. (graduated)
4. Jai J. (PostDoc – left CATT)
5. Tyler G. (Mech Eng. graduated)
6. Nigel (Mech Eng. Graduated)
7. Ateah S. (in progress)
8. Hadi G. (in progress)
9. Hamed M. (in progress)
10. Sevda P. (in progress)
11. Brendan S. (in progress)
12. Rob (in progress)
13. Lindsey (in progress)
14. Ramona M. (in progress)
15. Ahmed A. (applied for admission)
16. Kay A. (in progress)
17. Farid S. (Mech Eng. In progress)
18. Michael M. (Mech Eng., In progress)
19. Alison Z. (Mech Eng., In progress)

In 2018 CATT will:

### 8. Increase activity by other researchers

#### Update

Drs Unger (Earth Sciences), Haas (Civil Engg), Jhonson (Mech Engg), Briesly (AFM) and Cascante (Civil Engg) have been involved in various research initiatives.

Dr Alireza Bayat at University of Alberta

December 1, 2017



In 2018 CATT will:

**9. Promote development of municipal Water Infrastructure Fund**



**Update**

Met with Infrastructure Ontario and other organizations

Meetings with WaterTap

December 1, 2017



In 2018 CATT will:

**10. Third party evaluator for Water/wastewater infrastructure technologies through ETV**



**Update**

- CATT has been part of ETV (Environment Technology Verification) program of Environment Canada through John Neate, Globe Performance Solutions, from 2013-15
  - No project realized through ETV
- The Canadian ETV Program no longer exists. It has been replaced by an ISO ETV standard (ISO 14034)
  - John Neate co-founded a new international platform, VerifiGlobal, for providing ETV services based on ISO 14034
- GLOBE Performance Solutions Consortium agreement extended till Jul 31, 2019

December 1, 2017



In 2018 CATT will:

**10. Increase use of social media and web technologies**



**Update**

Increased use of LinkedIn and Twitter

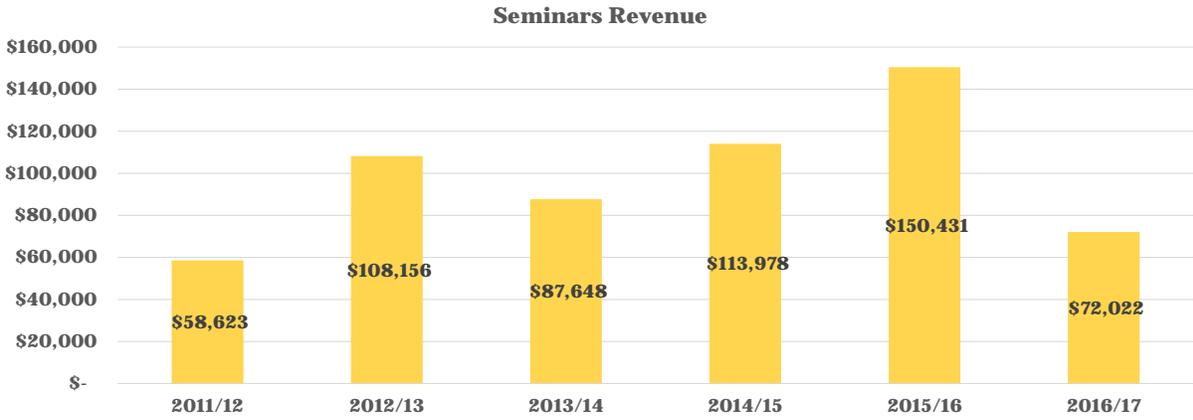
December 1, 2017 

In 2018 CATT will:

**11. Increase seminar/workshop revenue by 50**

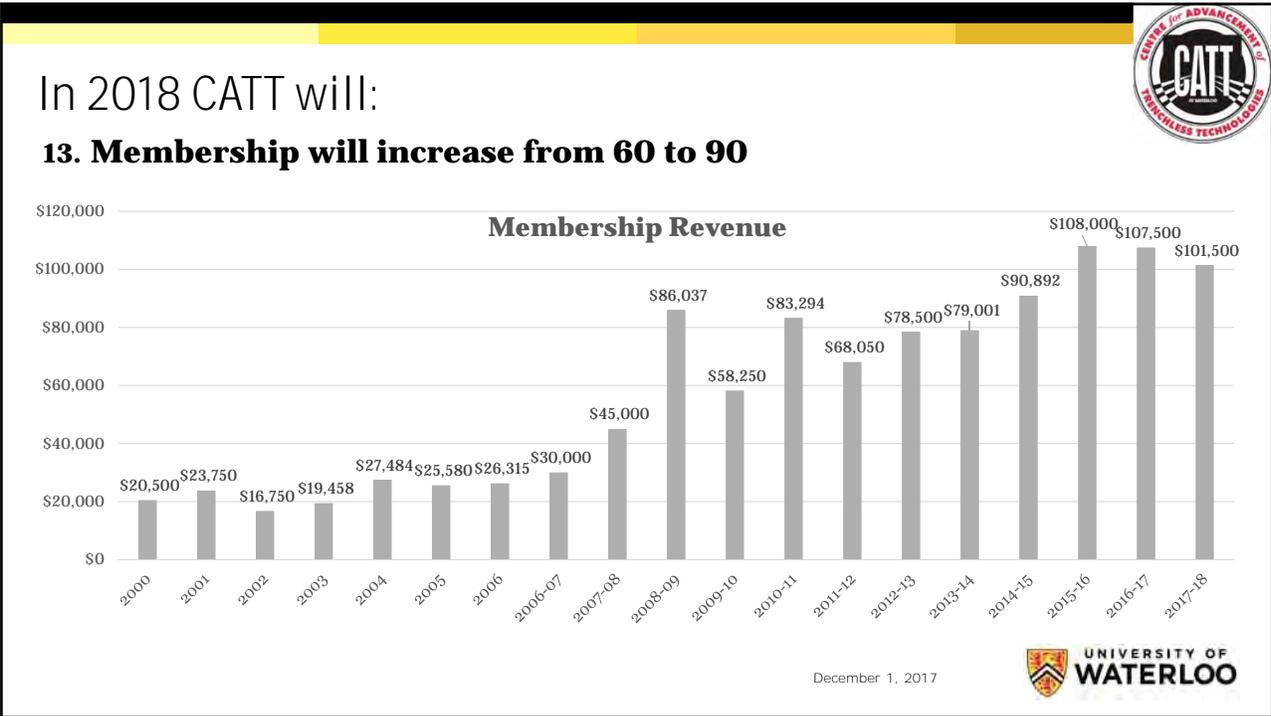
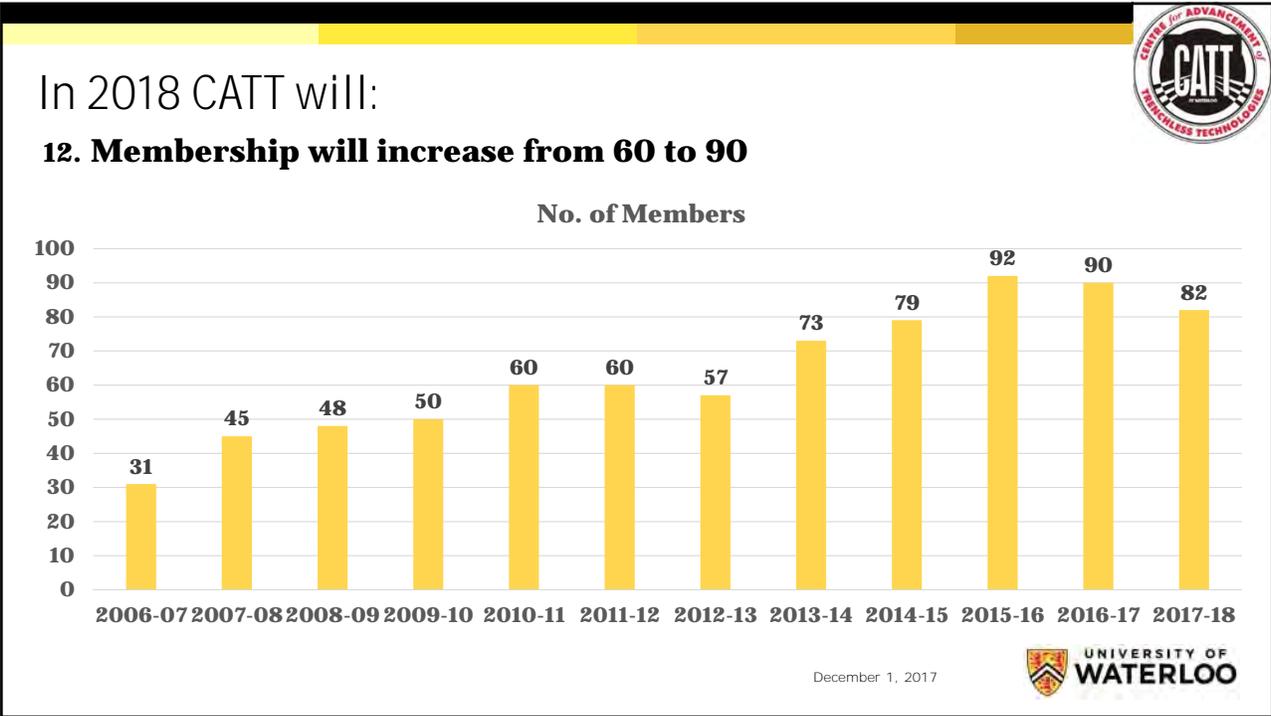


**Seminars Revenue**



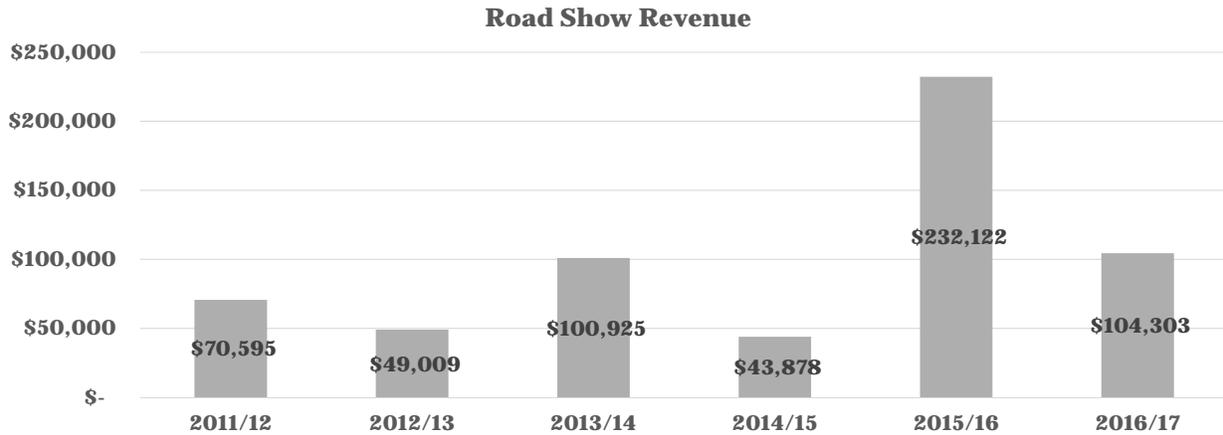
Fiscal Year	Seminars Revenue
2011/12	\$58,623
2012/13	\$108,156
2013/14	\$87,648
2014/15	\$113,978
2015/16	\$150,431
2016/17	\$72,022

December 1, 2017 



In 2018 CATT will:

**14. Increase Trenchless Roadshow net revenue from 40 to 80**



December 1, 2017



## SWOT Analysis

**The following slides are from the 2013/14 retreat and provided as a guide only. These should be updated at the 2017 retreat.**



December 1, 2017



## Strengths and Weaknesses



- 1. Focused Mandate on Buried Infrastructure**
- 2. Seminar and Workshops**
- 3. Roadshow**
- 4. Members**
- 5. Technical Committee**
- 6. Research and Contracts**
- 7. Organizational Structure**



## OPPORTUNITIES



1. Partnering with other organizations
  - a) CNAM/OGRA/ACTA
2. Use of web technologies
  - a) Social media/webinars/web broadcast
  - b) Membership renewals
  - c) Seminar/event registrations
  - d) Members only page on website
  - e) Access to technical information
3. Infrastructure finance
4. EPCIP
5. Failing infrastructure
6. Marketing
7. Provincial government
8. Increasing memberships
9. FCM conference in Niagara Falls 2014
10. APWA congress 2014



## Threats

1. Economy
2. Other Organizations/Associations offering trenchless seminars
3. NASTT (minor)
4. Other Universities
5. Offering of diploma/certification programs
6. Government
7. CSA, etc
8. UW Senate Report recommendations
9. Reliance on membership/seminar revenue



## 1. Focused Mandate on Buried Infrastructure

### Strengths

- Adaptability to industry needs
- Depth of Knowledge and Services
- Expertise / Technical
- Vehicle to facilitate industry change/needs

### Weaknesses

- Too focused / Scope too narrow
- Lack of awareness
- Limited market size
- Taken advantage of by Industry
- Lack of financial support
- Limited contacts outside the technical field
- Not enough researchers



## 2. Seminar and Workshops



### Strengths

- Technical more than 101
- Non commercial
- Topics timely – needs
- Affordable
- Committee
- Proactive planning
- Great speakers
- Networking
- Financially successful
- Reputation
- Industry leader
- Southern Ontario

### Weaknesses

- Marketing
- Limited Database/Connections (i.e. ability to communicate to larger target groups/potential audiences)
- Limited # of workshops outside of technical base
- Uncertainty (Attendance/Revenue)
- Volunteer driven
- Over worked Volunteers
- Administrative burden
- Competition/other events
- Lack of speakers
- Geographic limitations



## 3. Roadshows



### Strengths

- Major revenue source
- Major international marketing event
- Highlights TT industry to broad audience
- Unique to area/Canada
- Hands on demos
- Networking opportunities
- Advertising opportunities
- Organizing committee
- Reputation
- High quality presentations
- Benjamin Media Partnership

### Weaknesses

- Audience (target area limited, primarily from Southern Ontario & Upper New York State)
- Reduces workshop attendance
- Financial Risk
- Administrative burden
- Reliance on Benjamin Media



## 4. Members



### Strengths

- Financial support critical – base funding
- Broad cross section
- Industry leaders
- Low turnover in industry
- Succession of members
- Committed core members
- Supporting organizations
  - If use connections
- Support workshops/seminars

### Weaknesses

- Difficult to get new members
- Dependency on sole contact with an organization
- Retaining members
- Marketing / Communication
- Feedback (what are our members looking for?)
- Benefit without being a member
- No differentiation between size of company/organization
- Other organizations
- Recognized value of CATT membership
- Budgets (Limited Funding)
- Perception of influence from UW
- Geographical limitations
- Too much contact with members



## 5. Technical Committee



### Strengths

- Meaningful contribution to industry
- Address industry needs
- Advancement of the Industry
- Promotes and Develops Industry
- Development / Review of Specifications
- Committee
  - Motivated / Committed
  - Core
  - Diverse
- Advocate of Technologies

### Weaknesses

- Volunteer based
- Feedback / participation
- Awareness
- Timely completion of reviews (OPSS)
- Ineffective Dissemination
- Communication



## 6. Research / Contracts

### Strengths

- Differentiation from other organizations
- Training of Highly Quality Personal (HQP)
- Revenue Generator
- Development/Advancement Industry
- Identifies CATT as Industry Leader
- Awareness of innovative/new technologies
- Reputation
- University of Waterloo
- Incentives for Memberships

### Weaknesses

- Members awareness of resources available
- Market Perception / Too academic / Not industry friendly
- Too Cheap
- Limited faculty
- Cost and Resources
- Financial risk
- Cyclical nature
- Time to cultivate
- UW Overhead (~30%)
- Competition



## 7. Organizational Structure

### Strengths

- Financially Viable
- Active/Diverse Board
- Committed/Diverse Volunteers
- Permanent Full Time Support Staff
- Support from UW
  - Office of Research, Department, Dean
- University Resources
  - Printing
  - IT
  - Location/Office Space/Utilities
  - Marketing
  - HR
  - Finance
  - Facility for Seminars and Meetings

### Weaknesses

- Workload (educational programs) / limited staff
- Working within UW systems
- Identity
- Ecommerce ability
- No Managing Director
- Dependence on Key Personnel
- Reliance on volunteers
- No succession plan
- Limited revenue sources for expansion





## New CATT Initiatives or Action Items for:

- 2017/2018 Board Term
- Longer Term (2018-23)

December 1, 2017



## New CATT Initiatives or Action Items for Longer Term (2018-23)

- **Member Organizations**
  - Number of member organizations will increase 50% from about 90 to 135 (increased focus on municipalities)
  - Membership revenue will increase by 50% from \$100,000 to \$150,000
- **Staffing (TBD)**
  - **Action:** Put together organization chart and staffing needs (2 new staff members: (1) education and seminars; (2) admin...possible part time person, off-campus)
  - **Action:** Discuss with Mark and put together job descriptions, university grades, salary, and budget and send to BOD before Jan 2018 meeting
- **EPCIP: develop and deliver certification program**
  - Action: (1) pilot online/on-demand first with one or two courses
  - (2) funding
- **Continue to maintain, improve and grow Canadian Trenchless Directory**
  - Online as well as hard copy versions
  - **Action:** look at outsourcing ... (check owwa publisher???) or include in job description

December 1, 2017



## New CATT Initiatives or Action Items for Longer Term (2018-23)



- **Continue annual trenchless market survey**
  - **Action:** Dave and Bill will investigate annual publishing ...get quotes...
- **Include/invite municipalities to participate in the CATT events and they can present for 10-15 minutes on upcoming projects**
  - **Action:** Prapan can organize a one day or half day event on upcoming projects/plans...
- **Increased CATT industry profile with provincial/Federal government**
- **Research and HQP**
  - Increase cumulative research fund from \$2.4 million to \$3.6 million
  - Increase HQPs by 50%
- **Increase activity by other researchers**
- **Increase use of social media and web technologies**
  - **Action:** monitor traffic and include analytics for BOD meetings
- **Increase seminar/workshop revenue by 50% (from \$110k to \$165k)**
  - Also track the number of people trained and increase the number of trained people by 50% (take last years avg. and increase by 50%)
- **Road Shows**
  - Investigate eastern roadshow

December 1, 2017



## Appendix H: 2012-2019 Centre Related Publications

## **Awards**

2018 Pioneer Award Canadian Network of Asset Management (CNAM)

First Place Award at the 36th International Conference of the System Dynamics Society, Reykjavik-Iceland, (2018). Presentation title: "Development of an asset management planning tool for integrated wastewater collection and treatment systems".

First place award at the Canadian Network of Asset Management (CNAM) Conference, Windsor, Ontario, (2018). Presentation title: "Sustainability Assessment of Asset Management Plans of Wastewater Collection Network Systems".

Second place award at the Canadian Society of Civil Engineering (CSCE) Annual Conference, Vancouver, British Columbia, (2017). Presentation title: "Comprehensive sustainability assessment framework for water and wastewater infrastructure systems".

Third place award at the Canadian Network of Asset Management (CNAM) Conference, Halifax, Nova Scotia (2018). Presentation title: "Life Cycle Sustainability Assessment (LCSA) of urban water and wastewater".

## **Related Centre Publications 2012 to 2019**

Ganjidoost, A., Knight, M. A., Unger, A. J. A., & Haas, C. T. ( Under Review) Performance Modeling and Simulation for Water Distribution Networks Env. Modeling and Software Journal (Submit for Review March 2019).

Mohammadifardi, H., Knight M, and Unger A. (Under review) Sustainability assessment framework for municipal water asset management plans. Urban Water Journal. (Submitted February 2019).

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## Appendix I: Renewal Letters of Support

March 18, 2019

Senate Graduate and Research Council (SGRC)  
Research Leaders Council  
University of Waterloo

Dear Members of the Senate Graduate and Research Council,

**Subject: Letter of Support for renewal of the Centre for Advancement of Trenchless Technologies (CATT)**

The Faculty of Engineering is pleased to strongly support the renewal of the Centre for Advancement of Trenchless Technologies (CATT) for another term.

CATT is an international leader in trenchless technology research, implementation and education. They also serve our community of municipal engineers, academics and contractors as a critical nexus of knowledge management, networking and learning. Among their many activities, CATT has been offering non-credentialed courses to industry in the form of workshops/seminars since its formation back in 1994. More recently, CATT's training is Gold Seal, Engineer Institute Canada, and Ministry of Ontario Environment and Climate Change Director approved, to be offered as professional development credits to Industry professionals.

With the leadership of the Executive Director and the senior staff, they have become a significant asset to the University of Waterloo, the Faculty of Engineering and the Department of Civil and Environmental Engineering.

As a research centre, CATT provides a strong bridge between faculty members and Industry, as well as between graduate and undergraduate students and Industry. These industry linkages develop research funding opportunities, co-op positions, and assist with our goal to be recognized as an international leader in research, education and innovation.

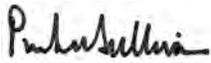
Over the past six years CATT has demonstrated exceptional growth in the area of water infrastructural renewal and asset management. This impressive growth has been achieved while CATT operated as a cost recovery Centre – it generates 100 percent of its revenue required to support the Centre operation without internal or external funds.



In 2018, the Canadian Network of Asset Managers recognized the research contributions from CATT with the *Pioneer Award*.

In summary, with the strong endorsement of the Department of Civil and Environmental Engineering, the Faculty of Engineering confirms its support for the renewal of the Centre for Advancement of Trenchless Technologies for another five years.

Yours very truly,



Pearl Sullivan  
Dean of Engineering

cc : Don Burn, Professor and Acting Chair  
Department of Civil and Environmental Engineering



March 14, 2019

Senate, University of Waterloo  
Research Leaders Council

**Subject: Letter of Support for renewal of the Centre for Advancement of Trenchless Technologies (CATT)**

Dear Members of the Research Council

It is a pleasure for the Department of Civil and Environmental Engineering to strongly support the renewal of the Centre for Advancement of Trenchless Technologies (CATT) for another term.

CATT is an international leader in trenchless technology research, implementation and education. They also serve our community of municipal engineers, academics and contractors as a critical nexus of knowledge management, networking and learning. With the leadership of the Executive Director and the senior staff, they have become a significant asset to the University of Waterloo, the Faculty of Engineering and the Department of Civil and Environmental Engineering.

CATT also provides a strong bridge between faculty members and Industry, as well as between graduate and undergraduate students and Industry. These industry linkages develop research funding opportunities, co-op positions, and assist with our goal to be recognized as an international leader in research, education and innovation.

Over the past six years CATT has demonstrated exceptional growth in the area of water infrastructural renewal and asset management. This impressive growth has been done while CATT has operated as a cost recovery Centre. In 2018, the Canadian Network of Asset Managers recognized the research contributions from CATT with the Pioneer Award. Graduate students associated with CATT have received awards at international conferences.

In summary, the Department of Civil and Environmental Engineering strongly supports the renewal of the Centre for Advancement of Trenchless Technologies for another term.

Sincerely,



Donald H. Burn, Ph.D., P.Eng.  
Professor and Acting Chair



March 13, 2019

Senate, University of Waterloo,  
Attn: Research Leaders Council,  
Subject: Renewal of The Center for Advancement of Trenchless Technologies.

Dear Members of the Research Leaders Council,

This letter is provided to Senate as support for the renewal of The Center for Advancement of Trenchless Technologies (CATT) for another term.

It is a pleasure to strongly support what has become a real success story in itself and for The University of Waterloo. On a personal basis, as an early Executive Director of CATT to 2002 when Professor Mark Knight took over, I am immensely pleased that the ensuing years to the present have seen an exceptional record of achievements. To Highlight a few:

- A strong foundation for continued growth, with demonstrated activities of research, education, professional training, financial stability, faculty involvement (CEE, MECH, Systems, Earth Sciences, Etc.) and overall outreach that has put CATT as a leader in the field both nationally and internationally.
- A three fold increase in CATT's paying members over the past decade from 30 to 90 present day. As well, CATT has organized and hosted over 90 industry training events involving over 5,000 professionals and has generated over \$2 million in revenue from these events. Moreover, the support of PhD's, Masters and Undergraduate students in CATT associated research has involved the securing of over \$3 million in research grants. This is all a truly remarkable record and further attests to CATT being a success story of which the University, its members and its leaders can be justifiably proud.

In addition to the foregoing highlights it should be noted that CATT is self sustaining without financial support required from UW or external grants and in fact has a substantial carry forward surplus.

In summary, I feel that CATT is eminently worthy of renewal by Senate, and I hope that my personal strong support will be taken into account.

Sincerely,



Ralph Haas, CM, FRSC, FCAE, DSc (Hon)

The Norman W. Mcleod Engineering Professor and Distinguished Professor Emeritus

Cc Dr. Mark Knight, Executive Director, CATT



**Waterloo. Ontario**    **Phone:**    (519) 888-4567    Ext. 32098  
**Canada. N2L 3G1**    **Fax:**        (519) 888-6197  
                                 **e-mail :**    gcascant@uwaterloo.ca



March 13, 2019

Dr. Mark Knight Executive Director  
Centre for Advancement of Trenchless Technologies  
Department of Civil and Environmental Engineering

**Re:    Support Letter for the Centre for the Advancement of Trenchless Technology  
      2019 Renewal**

It is my pleasure to provide a letter of support for the Centre for Trenchless Technologies (CATT) at the University of Waterloo. Over the past six years, CATT has allowed me to connect to industry partners to obtain research funds, data and to understand better the water infrastructure industry needs in the area of non-destructive evaluation of cast iron pipelines. CATT regularly host industry workshops and seminars; which provide an opportunity to connect with industry and to present my research results.

CATT has been and continues to provide unique organization at the University of Waterloo.

CATT is well managed Centre; and it has been a pleasure to see it to continue to grow over the years. I strongly support the Centre renewal and to continue to take advantage of industry and research initiatives at CATT.

Respectively submitted.

Sincerely,

A handwritten signature in black ink, appearing to read "Giovanni Cascante".

Giovanni Cascante Ph.D., P.Eng.  
Professor, Civil and Environmental Engineering Department  
Associate Chair for Graduate Studies

March 13, 2019

Dr Mark Knight Executive Director  
Centre for Advancement of Trenchless Technologies  
Department of Civil and Environmental Engineering  
University of Waterloo

**Letter of Support for the Centre for the Advancement of Trenchless Technology 2019 Renewal**

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Dear Dr. Knight:

It is my pleasure to provide a letter of support for the Centre for Trenchless Technologies (CATT) at the University of Waterloo. Over the past six years (2013 onwards) CATT has connected me with industry allowing a significantly funded multi-year project to be undertaken. This project with CATT led to new research directions for me and support for graduate students, co-op students and other researchers.

CATT regularly host industry workshops and seminars which also provide an opportunity to connect with industry and to present my research results. I have attended several CATT events and I have been surprised at the number of industry people involved and the spectrum of interests in CATT.

CATT has been and continues to provide unique organization at the University of Waterloo.

CATT is well managed and it has been a pleasure to see it to continue to grow over the years. I strongly support the centre renewal and will continue to take advantage of the opportunities presented with my association with CATT.

If you need more information, please do not hesitate to contact me.

Sincerely,

David A. Johnson PhD PEng

Professor  
Department of Mechanical and Mechatronics Engineering  
University of Waterloo  
Waterloo, Canada  
001 519 888 4567 ext 33690

David.Johnson@uwaterloo.ca

14<sup>th</sup> March 2019

Dr Mark Knight Executive Director  
Centre for Advancement of Trenchless Technologies  
Department of Civil and Environmental Engineering

**Letter of Support for the Centre for the Advancement of Trenchless Technology, 2019 Renewal**

It is my pleasure to provide a letter of support for the Centre for Trenchless Technologies (CATT) at the University of Waterloo.

Over the past six years, interacting with CATT and its associates has allowed me to broaden my perspectives and engage in cross-disciplinary research, so important at UW. Through CATT, I have been able to meet with industry partners to help obtain research funds, data and to better understand water infrastructure and industry needs.

CATT regularly hosts industry workshops and seminars which provide an opportunity to connect with industry and to present and discuss research results. CATT has been and continues to provide unique organization at the University of Waterloo.

CATT is well managed and it has been a pleasure to see it to continue to grow over the years. I strongly support the centre renewal, and fully expect to continue to take advantage of CATT in future.

Neil Brisley.

Neil Brisley  
Associate Professor of Finance, School of Accounting & Finance, Faculty of Arts.  
The Water Institute, Senior Management Committee Member (2017-to date).

March 13, 2019

Dr. Mark Knight, Executive Director  
Centre for Advancement of Trenchless Technologies (CATT)  
Department of Civil and Environmental Engineering

**Re: Faculty letter of support for CATT 2019 renewal**

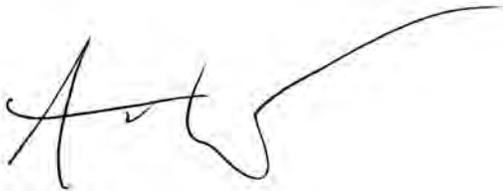
Dear Dr. Knight,

It is my pleasure to provide a letter of support for the Centre for Trenchless Technologies (CATT) at the University of Waterloo. I have been continuously working with CATT over the past ten years in the context of water infrastructure asset management. CATT has provided a forum that has allowed me to connect to industry partners to obtain research funds, data, and to communicate with industry professionals to better understand their needs. CATT also provides a mechanism to provide services to the water industry such as workshops and seminars that generate revenue, where this revenue can then be used for undergraduate and graduate student support.

CATT has been and continues to provide a unique organizational service at the University of Waterloo by being financially self-sufficient, providing a forum to organize student and faculty industry interests, and also providing outreach to professionals in the water industry.

CATT is well managed both administratively and financially, and it has been a pleasure to see it to continue to grow over the years. I strongly support CATT's renewal.

Yours Sincerely



André Unger, P.Eng. (Tel : 519-404-1984; [aunger@uwaterloo.ca](mailto:aunger@uwaterloo.ca))

March 14, 2019

Mr. Mark Knight, Executive Director  
Centre of Advancement of Trenchless Technologies  
Department of Civil Engineering  
University of Waterloo  
Waterloo, ON N2L 3G1

Dear Mr. Knight:

**RE: Senate Review**

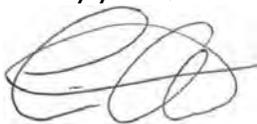
Please accept this letter in strong support of the Centre for Advancement of Trenchless Technology (CATT). The City of Waterloo has provided support of CATT since its inception in 1994 with representation on its Board of Directors, through staff instruction in seminars, delivery of papers and regular attendance at the international colloquiums and Roadshows, including the successful 2018 Roadshow in London, ON. In addition, our staff works directly with CATT and OGRA on the delivery of training for practitioners from across the province.

We actively support and recognize first hand, the benefits of a centre whose focus greatly assists municipalities through research and development of methodologies and skills that help address the increasing challenges of deteriorating infrastructure. Waterloo has now been successfully using trenchless technologies for our asset management strategy for decades and has reaped many continuing benefits.

CATT continues to be an exemplary leader in collective learning opportunities that actively and directly allow municipalities and industry staff to keep current their knowledge of this critical technology. Interaction with the industry proves fruitful to both CATT and industry as areas for future research are continually identified, discussed and often implemented. This international research network in underground infrastructure has brought worldwide knowledge to one table, in one language.

We sincerely thank the University of Waterloo, the Department of Civil Engineering, Office of Research and the faculty and staff associated with CATT for providing a forum for Industry and Academia to work side by side for advancement and mutual benefit.

Sincerely yours,



Tim Anderson, P.Eng  
Chief Administrative Officer, City of Waterloo

Cc: Roy Garbotz, Interim Director City Utilities, City of Waterloo  
Caroline Amyot, Senior Project Engineer, City of Waterloo



March 13, 2019

Centre for Advancement of Trenchless Technologies (CATT)  
University of Waterloo  
200 University Ave West  
Waterloo, ON  
N2L 3G1

ATTN: Dr. Mark Knight, Executive Director

**Re: Earth Boring's Continued Support and Commitment to CATT**

Dear Dr. Knight,

Earth Boring Co. Limited has been a trenchless contractor since 1947. In those 72 years, we have sought to develop strong relationships to support both our business and the trenchless industry. CATT has been an outstanding partner, highly valued in our works, and an excellent voice in the promotion and development of the trenchless industry.

CATT's wide member base, has provided Earth Boring with countless networking opportunities, better enabling our company to address the ever-advancing world of trenchless technologies and the industry as a whole. We delight as presenting contributors to CATT sponsored trenchless symposiums, conferences, and education sessions. These opportunities have been and remain rewarding on several different levels. Being able to share, collaborate, and exchange ideas has been among the greatest rewards of our CATT membership. We are often approached by design consultants and inspectors, who have attended the many CATT education sessions, to further collaborate on trenchless design projects. This underscores our commitment to ensuring that best practices are paramount in any trenchless design project, a commitment that CATT shares.

Earth Boring is proud to be an integral part and dedicated member of CATT, and we look forward to this year's education series and our continued partnership in 2019 and beyond.

Sincerely,

A handwritten signature in black ink, appearing to read 'Kyle Verwey', is written over a large, stylized blue scribble.

Kyle Verwey, P.Eng.  
Project Engineer  
Earth Boring Co. Limited

March 14, 2019

**Letter of Support - Center for Advancement of Trenchless Technologies (CATT) Renewal.**

To whom it may concern:

I am pleased to take this opportunity to recognize the support and leadership that Centre for Advancement of Trenchless Technologies (CATT) has provided for Insituform and AEGION Corporation in research and development efforts related to cured-in-place pipe pressure products.

Insituform is a world leader in the renewal of water and wastewater systems using trenchless construction methods. We strive to provide industry leading technically sound products and services, and our relationship with CATT and Dr. Mark Knight has supported these efforts. Over the past several years Insituform has been keenly involved as the Industry sponsor for the development of UWaterloo Hydrostatic burst test facility that will advance the design and performance of cured-in-place-pipe (CIPP) liners for Insituform and the industry. The CATT team, including Dr. Knight and graduate students, is a recognized resource for the industry in testing of CIPP products and CIPP design.

CATT industry education programs provide a wide range of instruction and sharing of information. These efforts combine industry leading resources and the CATT team. Education and sharing of information is critical for education of municipalities and engineers related to design, construction, and use of both currently widely implemented and innovative products, ensuring that they perform as intended and required. CATT is recognized as a leading organization in this regard in North America and the World.

We look forward to continuing our relationship with CATT and strongly support CATT renewal to maintain the industry leading research and education in the area water infrastructural renewal.

Sincerely,



George Bontus, P.Eng.  
Director of Engineering, Insituform Technologies Limited



March 14, 2019

Re: Center for Advancement of Trenchless Technologies (CATT) Letter of Support.

To Whom It May Concern,

We wish to take this opportunity to express our sincere appreciation for the support and assistance that we continue to receive from CATT in a variety of commercial and industry endeavours.

Envirologics originally developed the patented Tomahawk System™, an innovative trenchless method for cleaning and lining aging pressure pipes using airborne abrasives and polymerics. This novel system allowed us to provide fast, cost-effective cleaning, preparation and lining technology for water utilities and contractors for pipe rehabilitation applications. We continue to expand our performance envelope, and we depend on CATT's participation and support in our evolution.

CATT has been integral in moving our company from the technology research stage to commercialization within the water main rehabilitation market. The testing, analysis and validation services provided by Dr. Mark Knight and the CATT team of professionals have been instrumental in accelerating our commercialization within the water space. They have generated third-party credibility for our technology with rigorous, independent testing, evaluation and publishing of the technical results.

We are now securing technology pilots across North America and garnering interest overseas, and we reference CATT research papers to assist our commercialization efforts.

Our association with CATT has also included joint technical papers at CATT Road Show conferences, which they lead/host, and also included participation in valuable technical and educational forums such as Ontario Provincial Standard Specifications (OPSS) and Ontario Good Roads seminars. CATT is now firmly embedded in the trenchless world and has earned the respect of the many, diverse participants in this business, from municipalities to engineering firms.

**ENVIROLOGICS ENGINEERING INC**

5-193 MANITOBA STREET, BRACEBRIDGE, ONTARIO, P1L 1S3 TEL: 800-267-9810 WWW.ENVIROLOGICS.CA



As a small, innovative Ontario technology company, we consider CATT's role both integral and critical for the advancement of our business and our trenchless industry, and we will continue our strong relationship, our membership and our support for all that they do.

Yours sincerely,

A handwritten signature in black ink, consisting of a large, stylized 'R' followed by a smaller 'C' and a horizontal line extending to the right.

Randall J. Cooper  
P.Eng.  
President

**ENVIROLOGICS ENGINEERING INC**

5-193 MANITOBA STREET, BRACEBRIDGE, ONTARIO, P1L 1S3 TEL: 800-267-9810 WWW.ENVIROLOGICS.CA

**From Faculty of Applied Health Sciences (March 29, 2019)  
To Senate Graduate and Research Council**

**Graduate calendar changes for Applied Health Sciences**

**1. ACADEMIC PLAN CHANGES**

**1.1 Kinesiology\***

- 1.1.1 **Motion:** To revise the description of the PhD Comprehensive Examination requirements for all 3 Kinesiology Doctoral programs (KIN, AHWB, and WH), effective Fall 2019.

**Rationale:** To be consistent with the New University-level PhD Comprehensive examination minimum requirements, GSPA has initiated updating of calendar descriptions.

**Current Description:** (see attached Program Revision Template).

**Proposed Description:** (see attached Program Revision Template).

**1.2 Recreation and Leisure Studies\***

- 1.1.2 **Motion:** To change the calendar description of the comprehensive examination process, effective Fall 2019.

**Rationale:** The University has undergone a thorough review of all comprehensive examination process descriptions and asked all departments to ensure their processes are consistent with the University-level minimum requirements and to reduce redundancies where University and Department requirements are consistent.

What this means for RLS:

Our comprehensive examination process was already very consistent with the University minimum requirements (see New PhD Comprehensive Examination Minimum Requirements), however, some further detail has been added to our department guidelines (see Comprehensive Examination Procedures (for Doctoral students only)) to ensure everything the University wants covered in the guidelines is addressed. This description will be available on our RLS website and in our Graduate Handbook.

In order to reduce redundancy in the Graduate Studies Calendar that is produced each term, we have been asked to change our description in the Calendar to refer students to the University minimum requirements. Because our process is consistent with the minimum requirements of the University and RLS has no additional requirements, this is sufficient for our purposes. This motion is simply to approve the change to the Graduate Studies Calendar description (see attached Program Revision Template).

**Current Description:** (see attached Program Revision Template).

**Proposed Description:** (see attached Program Revision Template).

**1.3 School of Public Health and Health Systems\***

- 1.1.3 **Motion:** To specify SPHHS comprehensive examination requirements in the context of new University-level and Faculty-level requirements, effective Fall 2019.

**Rationale:** University of Waterloo Senate Graduate and Research Council (SGRC) and Senate recently approved new University-level PhD Comprehensive Examination minimum requirements

(effective fall 2019). The University-level requirements were written specifically to provide the opportunity for each Faculty and/or unit to create complementary text that is customized for their students but is consistent with the University-level requirements. This document specifies the following SPHHS-specific description and requirements:

The purpose of the comprehensive examination is to test the breadth and depth of the candidate's comprehension of the methodological and theoretical aspects of their field of study. The process is designed to enable candidates to acquire a solid grounding in their core area of public health research that will provide a foundation for undertaking dissertation research. The examination will also test the candidate's ability to critically evaluate the literature and synthesize information from sources to identify knowledge gaps and recommend solutions.

The comprehensive exam consists of three written questions followed by an oral examination. The written questions must be completed within eight weeks from the start date and the oral defence should be completed within four weeks of submission of the written examination.

**Current Description:** (see attached Program Revision Template).

**Proposed Description:** (see attached Program Revision Template).

## 2. COURSE CHANGES

### 2.1 School of Public Health and Health Systems\*

Minor changes to the Master of Public Health (MPH) Program and courses to ensure consistency with the Accreditation Criteria of the Council on Education for Public Health. These involve minor changes to HLTH 602B, HLTH 603, HLTH 605B, HLTH 614, and HLTH 617.

The following motions relate to revisions to the MPH program and specific courses offered to Professional Graduate Program Students in the School of Public Health and Health Systems.

These changes are brought forward at this time to enable the School to proceed with Accreditation by the Council on Education for Public Health, the period for accreditation commencing with the Fall 2019 MPH student intake.

#### 2.1.1 **Motion:** To revise HLTH 602B.

**Rationale:** To meet accreditation requirements we must provide a culminating experience for MPH students. In conjunction with HLTH 617, the existing HLTH 602B course largely accomplishes this: proposed revisions include some modifications to course content, a change from credit/non-credit marking, and identification of specific course activities, effective Fall 2019.

**Current Description:**

The culminating experience in the UW MPH program, the Capstone provides an opportunity for students to demonstrate two very important dimensions of readiness to practice in public health: the ability to work in a diverse and multidisciplinary team and the ability to integrate lessons learned from a variety of sources (including, but not limited to, course work and practicum) and bring them to bear on a concrete public health problem. Graded on a Credit/Non-Credit basis (the course is delivered in a two-week block at the end of the MPH program sequence, on the UW main campus).

**Proposed Description:**

The final culminating experience of the UW MPH program, the Capstone provides an opportunity for students to demonstrate their achievement of foundational knowledge and core competencies essential to the practice of public health. The course will include student presentations of capstone projects, workshops on leadership and working on inter-professional teams, and group work on current public health issues and problems (the course is delivered in a two-week block at the end of the MPH program sequence, on the UW main campus).

**2.1.2 Motion:** To revise HLTH 603.

**Rationale:** In order to meet accreditation requirements for the Council on Education for Public Health, slight course changes are needed to identify/flag how the course meets foundational knowledge and core competency requirements, effective Fall 2019.

**Current Description:**

A critical analysis of health policy formulation, implementation and evaluation related to population health initiatives and health care delivery. The course will include discussion of the role of various regional, provincial, and national agencies in health care policy formation. It will examine various health care systems, their funding and how the Canadian healthcare system compares with systems in other countries.

**Proposed Description:**

A critical analysis of health policy formulation, implementation and evaluation related to population health initiatives and health services delivery. The course will include discussion of health system financing, organization, management and regulation and the role of various regional, provincial, and national agencies in health policy formation. It will compare the Canadian health system with systems in other countries.

**2.1.3 Motion:** To revise HLTH 605B.

**Rationale:** In order to meet accreditation requirements for the Council on Education for Public Health and revision of course description to better reflect course content and learning outcomes, effective Fall 2019.

**Current Description:**

This course is an introduction to biostatistics for those planning a career in public health. Students will learn various bio statistical techniques, how to apply those techniques in the analysis of data from health studies, and how to interpret the results from those analyses. Topics include types of data, descriptive statistics, probability, distributions of data, exploratory data analysis, confidence intervals, hypothesis testing, regression analysis, analysis of variance, and brief exposure to categorical data analysis and survival analysis. Emphasis will be on conceptual understanding of topics as well as carrying out various data analysis applications.

**Proposed Description:**

This course is a rigorous introduction to biostatistics for those planning a career in public health. Students will learn various bio statistical techniques, how to apply those techniques in the analysis of data from health studies, and how to interpret the results from those analyses. After a brief review of material from a basic statistics course, topics covered will include simple and multiple

linear regression, analysis of categorical data, simple and multiple logistic regression, and survival analysis.

Emphasis will be on (i) conceptual understanding of topics, including literacy necessary for understanding scientific papers in public health, as well as (ii) carrying out various data analysis applications.

#### 2.1.4 **Motion:** To revise HLTH 614.

**Rationale:** In order to meet accreditation requirements for the Council on Education for Public Health, slight course changes are needed to identify/flag how the course meets foundational knowledge and core competency requirements, effective Fall 2019.

**Current Description:**

Methods and applications of intervention evaluation in public health, as a means to ensure effectiveness, accountability and continuous improvement of public health interventions. Basic evaluation models and concepts of evaluation design are provided as an introduction, including the relationship between intervention planning (organization and program planning) and evaluation. Case examples are used to illustrate methodological, political and ethical challenges of program evaluation in the public health context.

**Proposed Description:**

This course covers methods and applications of intervention evaluation in health, as a means to ensure the effectiveness, accountability and continuous improvement of public health interventions. Basic evaluation models and concepts of evaluation design are provided as an introduction, including the relationship between intervention planning (organization and program planning) and evaluation. Both qualitative and quantitative methodological approaches are presented. Case examples are used to illustrate methodological, political and ethical challenges of program evaluation in the public health context.

#### 2.1.5 **Motion:** To revise HLTH 617.

**Rationale:** To meet accreditation requirements we must provide a culminating experience for MPH students. In conjunction with HLTH 602B, the existing HLTH 617 course largely accomplishes this: proposed revisions flag that this is a capstone course, effective Fall 2019.

**Current Description:**

This course introduces the principals and methods for the effective design, selection and implementation of public health interventions to address socio-behavioural risk factors. At completion, students will be able to: determine when interventions are justified; differentiate individual and population level interventions; describe various types of interventions; use theory and evidence to select and design interventions including the appropriate mixes of intervention types, sites, and delivery systems. Emphasis is placed on self learning through reading and problem-based learning.

Lectures highlight and link important constructs, theories, perspectives, and bodies of evidence.

**Proposed Description:**

The first of two capstone courses in the MPH program, this course presents the and methods for the effective design, selection and implementation of public health interventions to address environmental, social, and behavioural risk factors. Students will determine when interventions are justified; differentiate between individual and population level interventions; describe various types

of interventions; and, use theory and evidence to select and design interventions including the appropriate mixes of intervention types, sites, and delivery systems. Emphasis is placed on developing a final project that integrates methods, concepts and theories in public health through reading and problem-based learning.

**\*attachment**

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Applied Health Science

**Program:** 1) Doctor of Philosophy (PhD) in Kinesiology  
 2) Doctor of Philosophy (PhD) in Kinesiology - Aging, Health and Well-Being  
 3) Doctor of Philosophy (PhD) in Kinesiology - Work and Health

**Program contact name(s):** Joe Quadrilatero, Denise Hay

**Form completed by:**

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/department-kinesiology/doctor-philosophy-phd-kinesiology>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/department-kinesiology/doctor-philosophy-phd-kinesiology-aging-health-and-well-being>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/department-kinesiology/doctor-philosophy-phd-kinesiology-work-and-health>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>◦ <del>Each student is required to write a comprehensive examination and complete an oral examination on selected aspects of the written examination.</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>◦ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>○ <del>The comprehensive examinations will normally occur on completion of the student's coursework and will begin during the fourth term of their program.</del></li> <li>○ <del>Students should consult the Department of Kinesiology Associate Chair for Graduate Studies for details concerning the administration procedure for this examination. When the written and oral examinations have been completed, the PhD comprehensive Examination Committee must arrive at one of the following decisions:</del> <ul style="list-style-type: none"> <li>▪ <del>Accepted (Passed)</del></li> <li>▪ <del>Accepted Conditionally</del></li> <li>▪ <del>Decision Deferred (Re-examination)</del></li> <li>▪ <del>Rejected (Failed)</del></li> </ul> </li> <li>○ <del>If the decision is "Decision Deferred (Re-examination)", students must complete this requirement no later than the end of the term following the term in which they initially attempted the comprehensive examinations. Re-examination does not necessarily imply a re-examination of both the written and oral aspects of the examination. If the decision is "Rejected (Failed)" the candidate is required to withdraw from the program.</del></li> </ul>	<p><u>(GSAC), with certain noted differences that are specific to the Faculty of Applied Health Sciences</u></p> <p><u>Comprehensive Examination minimum requirements:</u></p> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements. Note: In the Faculty of Applied Health Sciences, the novel research topic is tested through a separate thesis proposal process.</u></li> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: Consistent with University-level minimum requirements with the exception that in the Faculty of Applied Health Sciences, the composition of the comprehensive examining committee will be approved by the Associate Chair or Director, Graduate Studies for the student's Department/School, as delegated by the Associate Dean, Graduate Studies.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*Section will expand to accommodate content. Please include details here.*

**Departmental approval date (mm/dd/yy):**

**Reviewed by GSPA (for GSPA use only)  date (mm/dd/yy):** 12/13/2018

**Faculty approval date (mm/dd/yy):**

**Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):**

**Senate approval date (mm/dd/yy) (if applicable):**

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Applied Health Science

**Program:** 1) Doctor of Philosophy (PhD) in Recreation and Leisure Studies

2) Doctor of Philosophy (PhD) in Recreation and Leisure Studies - Aging, Health and Well-Being

3) Doctor of Philosophy (PhD) in Recreation and Leisure Studies - Work and Health

**Program contact name(s):** Sherry Dupuis, Tracy Taves

**Form completed by:**

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/department-recreation-and-leisure-studies/doctor-philosophy-phd-recreation-and-leisure-studies>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/department-recreation-and-leisure-studies/doctor-philosophy-phd-recreation-and-leisure-studies-aging-health-and-well-being>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/department-recreation-and-leisure-studies/doctor-philosophy-phd-recreation-and-leisure-studies-work-and-health>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>◦ <del>The purpose of the comprehensive examination is to ensure that doctoral students have a broad and comprehensive knowledge and understanding of the field of Recreation and Leisure Studies,</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>◦ Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the "<a href="#">Minimum requirements for the PhD degree</a>" section of the</li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><del>including: (1) different epistemological, methodological, and analytical approaches used within the field, and (2) one or more of the broad substantive areas of leisure studies. The process is designed to enable candidates to develop/acquire a solid grounding in and understanding of leisure studies. This process then provides a foundation for the critical analysis demanded by the dissertation proposal and final defence.</del></p> <ul style="list-style-type: none"> <li><del>o The comprehensive examination process normally will be completed over a period of six months. It involves both a written and an oral component. The comprehensive examination cannot be taken until all of the course requirements have been satisfied. The initiation of this examination is required normally within 16 months (4 terms) of admission and must be completed before submitting a thesis proposal. A comprehensive examination committee is comprised of at least three faculty members selected by the Departmental Graduate Studies Committee in consultation with the candidate.</del></li> </ul>	<p><u>Graduate Studies Academic Calendar (GSAC).</u></p> <ul style="list-style-type: none"> <li><del>o In addition to the University-level PhD Comprehensive Examination minimum requirements, students in the Faculty of Applied Health Sciences are also required to meet the following Faculty-level PhD Comprehensive Examination minimum requirements:</del> <ul style="list-style-type: none"> <li><del>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements. Note: In the Faculty of Applied Health Sciences, the novel research topic is tested through a separate thesis proposal process.</u></del></li> <li><del>▪ <u>Timing: Consistent with University-level minimum requirements.</u></del></li> <li><del>▪ <u>Committee: In the Faculty of Applied Health Sciences, the composition of the comprehensive examining committee will be approved by the Associate Chair or Director, Graduate Studies for the student's Department/School, as delegated by the Associate Dean, Graduate Studies.</u></del></li> <li><del>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements.</u></del></li> <li><del>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></del></li> <li><del>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></del></li> </ul> </li> <li><del>o <u>In addition to the University level and Faculty level PhD Comprehensive Examination minimum requirements, students in the PhD in Recreation and Leisure Studies program are also required to meet the following requirements:</u></del></li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*Section will expand to accommodate content. Please include details here.*

Departmental approval date (mm/dd/yy): 29/01/19

Reviewed by GSPA (for GSPA use only)  date (mm/dd/yy):

Faculty approval date (mm/dd/yy):

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy): Senate approval date (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs.

**Faculty:** Applied Health Science

**Program:** 1) Doctor of Philosophy (PhD) in Public Health and Health Systems  
2) Doctor of Philosophy (PhD) in Public Health and Health Systems - Aging, Health and Well-Being  
3) Doctor of Philosophy (PhD) in Public Health and Health Systems - Water  
4) Doctor of Philosophy (PhD) in Public Health and Health Systems - Work and Health

**Program contact name(s):** Ellen MacEachen, Dan Rodgers

**Form completed by:**

[Description of proposed changes:](#)

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updating the PhD Comprehensive Examination description and requirements.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To be consistent with the new University-level PhD Comprehensive Examination minimum requirements.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/school-public-health-and-health-systems/doctor-philosophy-phd-public-health-and-health-systems>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/school-public-health-and-health-systems/doctor-philosophy-phd-public-health-and-health-systems-aging-health-and-well-being>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/school-public-health-and-health-systems/doctor-philosophy-phd-public-health-and-health-systems-water>

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/school-public-health-and-health-systems/doctor-philosophy-phd-public-health-and-health-systems-work-and-health>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>◦ <del>Candidates must complete a PhD Comprehensive Examination within seven terms of first registration. The comprehensive examination requirement is based on providing written responses to three questions and successfully completing an oral defense. The purpose of the comprehensive examination is to test the breadth and depth of the candidate’s comprehension of the methodological and theoretical aspects of their field of study. The process is designed to enable candidates to acquire a solid grounding in their core area of public health research that will provide a foundation for undertaking dissertation research. The examination will also test the candidate’s ability to critically evaluate the literature and synthesize information from sources to identify knowledge gaps and recommend solutions.</del></li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b>PhD Comprehensive Examination</b> <ul style="list-style-type: none"> <li>◦ <u>Students are required to meet the University-level PhD Comprehensive Examination minimum requirements outlined in the “<a href="#">Minimum requirements for the PhD degree</a>” section of the Graduate Studies Academic Calendar (GSAC), with certain noted differences that are specific to the Faculty of Applied Health Sciences Comprehensive Examination minimum requirements:</u> <ul style="list-style-type: none"> <li>▪ <u>Comprehensive examination purpose: Consistent with University-level minimum requirements. Note: In the Faculty of Applied Health Sciences, the novel research topic is tested through a separate thesis proposal process.</u></li> <li>▪ <u>Timing: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Committee: In the Faculty of Applied Health Sciences, the composition of the comprehensive examining committee will be approved by the Associate Chair or Director, Graduate Studies for the student’s Department/School, as delegated by the Associate Dean, Graduate Studies.</u></li> <li>▪ <u>Who Chairs an examination: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Format / Content: Consistent with University-level minimum requirements.</u></li> <li>▪ <u>Academic integrity: Consistent with University-level minimum requirements.</u></li> </ul> </li> <li>◦ <u>In addition to the University-level and Faculty-level PhD Comprehensive Examination minimum requirements, students in the PhD in Public Health and Health Systems must also note the following:</u></li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<ul style="list-style-type: none"> <li>▪ The purpose of the comprehensive examination is to test the breadth and depth of the candidate’s comprehension of the methodological and theoretical aspects of their field of study. The process is designed to enable candidates to acquire a solid grounding in their core area of public health research that will provide a foundation for undertaking dissertation research. The examination will also test the candidate’s ability to critically evaluate the literature and synthesize information from sources to identify knowledge gaps and recommend solutions.</li> <li>▪ <u>The comprehensive examination consists of three written questions followed by an oral examination. The written questions must be completed within eight weeks from the start date and the oral defence should be completed within four weeks of submission of the written examination.</u></li> </ul>

**How will students currently registered in the program be impacted by these changes?**

*These changes will apply only to students who begin their program when these regulations are established. Students who began in prior years will be assessed based on comprehensive examination guidelines that were in place at the start of their program.*

**Departmental approval date** (mm/dd/yy): 02/13/19

**Reviewed by GSPA** (for GSPA use only)  date (mm/dd/yy): 02/08/2019

**Faculty approval date** (mm/dd/yy):

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

**Faculty:** Applied Health Science

**Program:** Master of Public Health (MPH)

**Program contact name(s):** Craig Janes

**Form completed by:** Craig Janes

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Section will expand to accommodate content. Please include details here.*

Is this a [major modification](#) to the program? Yes

**Rationale for change(s):**

*The School of Public Health and Health Systems is seeking formal, international accreditation of the MPH program from the Council on Education for Public Health (CEPH). The following curricular modifications and adjustments to the length of the program are required in order to meet foundational knowledge and core competency requirements. See: [https://storage.googleapis.com/media.ceph.org/wp\\_assets/2016.Criteria.pdf](https://storage.googleapis.com/media.ceph.org/wp_assets/2016.Criteria.pdf). The modifications mainly involve moving courses currently required for only those completing the "Socio-Behavioural Sciences" field to the core program for all students. The Socio-Behavioural Sciences field option is thus no longer needed and should be eliminated. CEPH requires all accredited MPH programs to be the equivalent of 42 credit hours in length (in the U.S. system). This is roughly equivalent to 7.50 unit weights of coursework in the University of Waterloo system. This requires that we increase the total course requirements by one, 0.50 unit weight course. The renaming of the Environmental Health Sciences Field is to be consistent with new University definitions.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/applied-health-sciences/school-public-health-and-health-systems/master-public-health-mph>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>Graduate research fields</p> <ul style="list-style-type: none"> <li>• <del>Environmental Health Sciences</del></li> <li>• <del>Socio-Behavioural Sciences</del></li> </ul> <p>Program information</p> <ul style="list-style-type: none"> <li>• Admit term(s) <ul style="list-style-type: none"> <li>○ Fall</li> </ul> </li> <li>• Delivery mode <ul style="list-style-type: none"> <li>○ Online</li> </ul> </li> <li>• Delivery mode information <ul style="list-style-type: none"> <li>○ <del>The program is also offered on-campus or in a mix of online and on-campus formats.</del></li> </ul> </li> <li>• Length of program <ul style="list-style-type: none"> <li>○ Full-time: two years (20 months).</li> <li>○ Part-time: four years from initial program entry.</li> <li>○ Courses are offered in three terms of each academic year. For all, continuous registration for each term of the program is required.</li> </ul> </li> <li>• Program type <ul style="list-style-type: none"> <li>○ Master's</li> <li>○ Professional</li> </ul> </li> <li>• Registration option(s) <ul style="list-style-type: none"> <li>○ Full-time</li> <li>○ Part-time</li> </ul> </li> <li>• Study option(s) <ul style="list-style-type: none"> <li>○ <b><u>Coursework</u></b></li> </ul> </li> </ul> <p>Admission requirements</p> <ul style="list-style-type: none"> <li>• Minimum requirements <ul style="list-style-type: none"> <li>○ Successful completion of a four-year Honours Bachelor's degree (or equivalent) with a minimum 75% average. The Bachelor's degree will normally be in a field relevant to public health.</li> <li>○ Students must submit a personal essay of no more than 500 words explaining the education, work and life experiences 1) that have brought them to the decision to apply to the</li> </ul> </li> </ul>	<p>Graduate research fields</p> <p>Program information</p> <ul style="list-style-type: none"> <li>• Admit term(s) <ul style="list-style-type: none"> <li>○ Fall</li> </ul> </li> <li>• Delivery mode <ul style="list-style-type: none"> <li>○ Online</li> </ul> </li> <li>• Delivery mode information <ul style="list-style-type: none"> <li>○ <u>All students must attend (two) two week on-campus courses. The rest of the courses can be completed fully online. Some courses may also be offered on campus.</u></li> </ul> </li> <li>• Length of program <ul style="list-style-type: none"> <li>○ Full-time: two years.</li> <li>○ Part-time: four years from initial program entry.</li> <li>○ Courses are offered in three terms of each academic year. For all, continuous registration for each term of the program is required.</li> </ul> </li> <li>• Program type <ul style="list-style-type: none"> <li>○ Master's</li> <li>○ Professional</li> </ul> </li> <li>• Registration option(s) <ul style="list-style-type: none"> <li>○ Full-time</li> <li>○ Part-time</li> </ul> </li> <li>• Study option(s) <ul style="list-style-type: none"> <li>○ <b><u>Coursework</u></b></li> </ul> </li> </ul> <p>Admission requirements</p> <ul style="list-style-type: none"> <li>• Minimum requirements <ul style="list-style-type: none"> <li>○ Successful completion of a four-year Honours Bachelor's degree (or equivalent) with a minimum 75% average. The Bachelor's degree will normally be in a field relevant to public health.</li> <li>○ Students must submit a personal essay of no more than 500 words explaining the education, work and life experiences 1) that have brought them to the decision to apply to the</li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>MPH program; and 2) how the MPH will help them in their future career.</p> <ul style="list-style-type: none"> <li>○ Students must have <del>at least one year of</del> prior work experience in a public health setting, either through full or part-time employment or through co-operative work terms as an undergraduate (volunteer experience <del>may be</del> applicable).</li> <li>○ <del>Although statistics is not a prerequisite for admission,</del> students <del>should</del> have a suitable background in statistics to meet prerequisite standards for all graduate level courses, before beginning coursework. An undergraduate course in <del>research</del> methods (with a minimum 75%) is <del>recommended</del>.</li> <li>○ Students will be recruited as recent graduates from 4-year Bachelor of Science (BSc) or Bachelor of Arts (BA) programs in Health Studies and related disciplines, or alternatively as mature students holding a 4-year degree in a related discipline with relevant work experience in population and public health. Students with advanced professional degrees in recognized health disciplines (e.g. MD, DVM) <del>will also be</del> eligible for admission.</li> </ul> <ul style="list-style-type: none"> <li>● Application materials <ul style="list-style-type: none"> <li>○ Résumé <ul style="list-style-type: none"> <li>▪ Indicating past academic and professional experience.</li> </ul> </li> <li>○ Supplementary information form</li> <li>○ Transcript(s)</li> </ul> </li> <li>● References <ul style="list-style-type: none"> <li>○ Number of references: 2</li> <li>○ Type of references: <ul style="list-style-type: none"> <li>○ 1 academic</li> <li>○ 1 professional</li> <li>○ If applicants have been out of school for an extended period of time (&gt;5 years) and are unable to supply an academic reference they may submit</li> </ul> </li> </ul> </li> </ul>	<p>MPH program; and 2) how the MPH will help them in their future career.</p> <ul style="list-style-type: none"> <li>○ <u>Normally</u>, students <u>will</u> have prior work experience in a public health setting, either through full or part-time employment or through co-operative work terms as an undergraduate (volunteer experience <u>is</u> applicable).</li> <li>○ Students <u>must</u> have a suitable background in statistics to meet prerequisite standards for all graduate level courses before beginning coursework. An undergraduate course in <u>statistical methods completed within the past five years</u> with a minimum <u>mark of 75%</u> is <u>required</u>. <u>Exceptions to this requirement may be made on occasion by admission committees considering student background and demonstrated analytic abilities.</u></li> <li>○ Students will be recruited as recent graduates from 4-year Bachelor of Science (BSc) or Bachelor of Arts (BA) programs in Health Studies and related disciplines, or alternatively as mature students holding a 4-year degree in a related discipline with relevant work experience in population and public health. Students with advanced professional degrees in recognized health disciplines (e.g. MD, DVM) <u>are</u> also eligible for admission.</li> </ul> <ul style="list-style-type: none"> <li>● Application materials <ul style="list-style-type: none"> <li>○ Résumé <ul style="list-style-type: none"> <li>▪ Indicating past academic and professional experience.</li> </ul> </li> <li>○ Supplementary information form</li> <li>○ Transcript(s)</li> </ul> </li> <li>● References <ul style="list-style-type: none"> <li>○ Number of references: 2</li> <li>○ Type of references: <ul style="list-style-type: none"> <li>○ 1 academic</li> <li>○ 1 professional</li> <li>○ If applicants have been out of school for an extended period of time (&gt;5 years) and are unable to supply an academic reference they may submit</li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>two professional references. Please ensure that one professional referee is able to comment on the applicants academic ability and potential.</p> <ul style="list-style-type: none"> <li>• <b><u>English language proficiency (ELP)</u></b> (if applicable)</li> </ul> <p>Degree requirements</p> <p>Coursework option:</p> <ul style="list-style-type: none"> <li>• <b><u>Graduate Academic Integrity Module (Graduate AIM)</u></b></li> <li>• Courses <ul style="list-style-type: none"> <li>○ The minimum course requirements are <del>10</del> one-term (0.50 unit weight) graduate courses, 2 two-week block courses (0.50 total weight) and a practicum (1.50 unit weight).</li> <li>○ Students will attend on-campus on two occasions for 2-week block courses. The first, HLTH 602A Foundations of Public Health, will occur at the start of the program and the second, HLTH 602B Capstone Integrative Seminar for Public Health, will bring students back together at the end of the program after completion of all coursework and the practicum: <ul style="list-style-type: none"> <li>▪ The objective of HLTH 602A, the Foundations of Public Health course is <del>both to orient the student to the philosophical and practical bases of public health, and to kindle the student's passion for public health as a career and as a societal activity.</del></li> <li>▪ HLTH 602B, <del>the MPH capstone course, will provide an opportunity to apply public health tools, concepts and best practice to address current issues facing public health organizations and build relationships with front line</del></li> </ul> </li> </ul> </li> </ul>	<p>two professional references. Please ensure that one professional referee is able to comment on the applicants academic ability and potential.</p> <ul style="list-style-type: none"> <li>• <b><u>English language proficiency (ELP)</u></b> (if applicable)</li> </ul> <p>Degree requirements</p> <p>Coursework option:</p> <ul style="list-style-type: none"> <li>• <b><u>Graduate Academic Integrity Module (Graduate AIM)</u></b></li> <li>• Courses <ul style="list-style-type: none"> <li>○ The minimum course requirements are <u>11</u> one-term (0.50 unit weight) graduate courses, 2 block courses <u>requiring two-weeks on campus</u> (0.50 total weight) and a practicum (1.50 unit weight).</li> <li>○ Students will attend on-campus on two occasions for 2-week block courses. The first, HLTH 602A Foundations of Public Health, will occur at the start of the program and the second, HLTH 602B Capstone Integrative Seminar for Public Health, will bring students back together at the end of the program after completion of all coursework and the practicum: <ul style="list-style-type: none"> <li>▪ The objective of HLTH 602A, the Foundations of Public Health course is <u>to provide students with foundational knowledge of public health, orient the student to the philosophical and practical bases of public health, and to kindle the student's passion for public health as a career and as a societal activity.</u></li> <li>▪ HLTH 602B, <u>the final MPH capstone course, is a culminating integrated learning experience that provides a context for</u></li> </ul> </li> </ul> </li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><del>public health practitioners. On campus preparation and completion of assignments during the spring term are also requirements for the completion of HLTH 602B.</del></p> <ul style="list-style-type: none"> <li>○ Additional required courses are as follows: <ul style="list-style-type: none"> <li>▪ HLTH 604 Public Health and the Environment</li> <li>▪ HLTH 605B Quantitative Methods and Analysis</li> <li>▪ HLTH 606B Principles of Epidemiology for Public Health</li> <li>▪ HLTH 607 Social, Cultural and Behavioural Aspects of Public Health I</li> <li>▪ HLTH 608 Health and Risk Communication in Public Health</li> <li>▪ HLTH 609 Management and Administration of Public Health Services</li> <li>▪ <del>PHS 603 Health Policy in Public Health</del></li> <li>▪ <del>PHS 641 Professional Experience Practicum</del></li> </ul> </li> <li>○ At a minimum, students must obtain an average of 75% or higher in aggregate on the courses presented in fulfilment of the degree requirements. Grades on all courses presented to fulfill the degree requirements must be 70% or higher. A grade below 70% in any course or failing to maintain an average of 75% will necessitate a review of the student's status by the School and may result in a student being required to complete additional coursework or being required to withdraw from the program. The School reserves the right to stipulate additional coursework if it is necessary for the student's preparation.</li> <li>○ To graduate from the environmental health sciences stream, a student is required to complete the required</li> </ul>	<p><u>students to demonstrate their achievement of the foundational knowledge and core competencies of public health. On-campus workshops and preparation and presentation of a capstone project are required for the completion of this course.</u></p> <ul style="list-style-type: none"> <li>○ Additional required courses are as follows: <ul style="list-style-type: none"> <li>▪ <u>HLTH 603 Health Systems and Policy</u></li> <li>▪ HLTH 604 Public Health and the Environment</li> <li>▪ HLTH 605B Quantitative Methods and Analysis</li> <li>▪ HLTH 606B Principles of Epidemiology for Public Health</li> <li>▪ HLTH 607 Social, Cultural and Behavioural Aspects of Public Health I</li> <li>▪ HLTH 608 Health and Risk Communication in Public Health</li> <li>▪ HLTH 609 Management and Administration of Public Health Services</li> <li>▪ <u>HLTH 614 Foundations of Program Evaluation</u></li> <li>▪ <u>HLTH 617 Population Intervention for Disease Prevention and Health Promotion</u></li> <li>▪ <u>HLTH 640 Professional Experience Practicum</u></li> </ul> </li> <li>○ At a minimum, students must obtain an average of 75% or higher in aggregate on the courses presented in fulfilment of the degree requirements. Grades on all courses presented to fulfill the degree requirements must be 70% or higher. A grade below 70% in any course or failing to maintain an average of 75% will necessitate a review of the student's status by the School of <u>Public Health and Health Systems (SPHHS)</u> and may result in a student being required</li> </ul>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>core courses plus <del>2 stream specific courses</del> HLTH 624 Environmental Toxicology in Public Health and HLTH 634 Environmental Epidemiology for Public Health. <del>and at least 1 elective from the listed HLTH or equivalent courses.</del></p> <ul style="list-style-type: none"> <li><del>○ To graduate from the socio-behavioural sciences stream, a student is required to complete the required core courses plus 2 stream specific courses HLTH 614 Foundations of Program Evaluation and HLTH 617 Population Intervention for Disease Prevention and Health Promotion and at least 1 elective from the listed HLTH or equivalent courses.</del></li> <li>○ MPH general degree students will be required to complete the required core courses as well as <del>3</del> elective HLTH courses. Graduate courses from other departments may be acceptable if approved by the MPH Program Committee.</li> <li>○ Students admitted for a probationary year will be required to complete HLTH 605B Quantitative Methods and Analysis (fall term) and HLTH 606B Principles of Epidemiology for Public Health (winter term) with an average of at least 73%. If a student's average on these courses falls below 73% but not below 70%, their status will be reviewed by the <b>Department Graduate Committee</b>. Normally a student will not continue on probationary status for more than two terms.</li> </ul>	<p>to complete additional coursework or being required to withdraw from the program. The School reserves the right to stipulate additional coursework if it is necessary for the student's preparation.</p> <ul style="list-style-type: none"> <li>○ <u>To graduate from the environmental health sciences concentration</u>, a student is required to complete the required core courses plus HLTH 624 Environmental Toxicology in Public Health and HLTH 634 Environmental Epidemiology for Public Health.</li> <li>○ MPH general degree students will be required to complete the required core courses as well as 2 elective HLTH courses. Graduate courses from other departments may be acceptable if approved by the <u>SPHHS Professional Graduate Programs Committee</u>.</li> <li>○ Students admitted for a probationary year will be required to complete HLTH 605B Quantitative Methods and Analysis (fall term) and HLTH 606B Principles of Epidemiology for Public Health (winter term) with an average of at least 73%. If a student's average on these courses falls below 73% but not below 70%, their status will be reviewed by the <u>SPHHS Professional Graduate Programs Committee</u>. Normally a student will not continue on probationary status for more than two terms.</li> </ul>

How will students currently registered in the program be impacted by these changes?

*Students currently in the program will complete the requirements specified during the calendar year of their entry. Only students matriculating after Fall 2019 will be required to take the slightly revised curriculum provided here.*

Departmental approval date (mm/dd/yy): 01/28/19

Reviewed by GSO (for GSO use only)  date (mm/dd/yy):

Faculty approval date (mm/dd/yy): 01/28/19

Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy): Senate approval date (mm/dd/yy) (if applicable)

Faculty: Applied Health Science

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation

Milestone  New  Revision  Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites) Minor modifications to description, change from credit/non-credit to numerical marking.

Course Subject code: Choose an item. Course number: HLTH 602B

Course Title (max. 100 characters incl. spaces): Capstone Integrative Seminar for Public Health

Course Short Title (max. 30 characters incl. spaces): Capstone Seminar

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:  Department

Course Description:

The culminating experience in the UW MPH program, the Capstone provides an opportunity for students to demonstrate two very important dimensions of readiness to practice in public health: the ability to work in a diverse and multidisciplinary team and the ability to integrate lessons learned from a variety of sources (including, but not limited to, course work and practicum) and bring them to bear on a concrete public health problem. Graded on a Credit/Non-Credit basis. (The course is delivered in a two-week block at the end of the MPH program sequence, on the UW main campus).

New course description (for revision only):

The final culminating experience of the UW MPH program, the Capstone provides an opportunity for students to demonstrate their achievement of foundational knowledge and core competencies essential to the practice of public health. The course will include student presentations of capstone projects, workshops on leadership and working on inter-professional teams, and group work on current public health issues and problems (The course is delivered in a two-week block at the end of the MPH program sequence, on the UW main campus).

Meet Type(s): Lecture Lecture Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites: MPH students only, HLTH 640, Also offered online

Special topics course: Yes  No

Cross-listed: Yes  No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request: To meet accreditation requirements we must provide a culminating experience for MPH students. In conjunction with HLTH 617, the existing HLTH 602B course largely accomplishes this: proposed revisions include some modifications to course content, a change from credit/non-credit marking, and identification of specific course activities.

Faculty: Applied Health Science

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation

Milestone  New  Revision  Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:  
(e.g. consent, description, title, requisites) Description, title.

Course Subject code: Choose an item. Course number: HLTH 603

Course Title (max. 100 characters incl. spaces): Health Systems and Policy

Course Short Title (max. 30 characters incl. spaces): Health Systems

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:  Choose an item.

Course Description:

A critical analysis of health policy formulation, implementation and evaluation related to population health initiatives and health care delivery. The course will include discussion of the role of various regional, provincial, and national agencies in health care policy formation. It will examine various health care systems, their funding and how the Canadian healthcare system compares with systems in other countries.

New course description (for revision only):

A critical analysis of health policy formulation, implementation and evaluation related to population health initiatives and health services delivery. The course will include discussion of health system financing, organization, management and regulation and the role of various regional, provincial, and national agencies in health policy formation. It will compare the Canadian health system with systems in other countries.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites](#): SPHHS students only, Also offered Online

Special topics course: Yes  No

Cross-listed: Yes  No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: In order to meet accreditation requirements for the Council on Education for Public Health, slight course changes are needed to identify/flag how the course meets foundational knowledge and core competency requirements.

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Prepared by:

Date: 14-Dec-18

Faculty: Applied Health Science

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation

Milestone  New  Revision  Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites) Minor modifications to description, remove antireq HSG 605.

Course Subject code: Choose an item. Course number: HLTH 605B

Course Title (max. 100 characters incl. spaces): Quantitative Methods and Analysis

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:  Department

Course Description:

This course is an introduction to biostatistics for those planning a career in public health. Students will learn various biostatistical techniques, how to apply those techniques in the analysis of data from health studies, and how to interpret the results from those analyses. Topics include types of data, descriptive statistics, probability, distributions of data, exploratory data analysis, confidence intervals, hypothesis testing, regression analysis, analysis of variance, and brief exposure to categorical data analysis and survival analysis. Emphasis will be on conceptual understanding of topics as well as carrying out various data analysis applications.

New course description (for revision only):

This course is a rigorous introduction to biostatistics for those planning a career in public health. Students will learn various biostatistical techniques, how to apply those techniques in the analysis of data from health studies, and how to interpret the results from those analyses. After a brief review of material from a basic statistics course, topics covered will include simple and multiple linear regression, analysis of categorical data, simple and multiple logistic regression, and survival analysis. Emphasis will be on (i) conceptual understanding of topics, including literacy necessary for understanding scientific papers in public health, as well as (ii) carrying out various data analysis applications.

Meet Type(s): Lecture Lecture Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites](#): SPHHS students only, Only offered Online

Special topics course: Yes  No

Cross-listed: Yes  No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request: Revision to course description to better reflect course content and learning outcomes.

Prepared by:

Date: 14-Dec-18

Faculty: Applied Health Science

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation

Milestone  New  Revision  Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites) Minor modifications to description, remove antireq HSG 604

Course Subject code: Choose an item. Course number: HLTH 614

Course Title (max. 100 characters incl. spaces): Foundations of Program Evaluation

Course Short Title (max. 30 characters incl. spaces): Program Evaluation

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:  Choose an item.

Course Description:

Methods and applications of intervention evaluation in public health, as a means to ensure the effectiveness, accountability and continuous improvement of public health interventions. Basic evaluation models and concepts of evaluation design are provided as an introduction, including the relationship between intervention planning (organization and program planning) and evaluation. Case examples are used to illustrate methodological, political and ethical challenges of program evaluation in the public health context.

New course description (for revision only):

This course covers methods and applications of intervention evaluation in public health, as a means to ensure the effectiveness, accountability and continuous improvement of public health interventions. Basic evaluation models and concepts of evaluation design are provided as an introduction, including the relationship between intervention planning (organization and program planning) and evaluation. Both qualitative and quantitative methodological approaches are presented. Case examples are used to illustrate methodological, political and ethical challenges of program evaluation in the public health context.

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites](#): SPHHS students only, Also offered Online

Special topics course: Yes  No

Cross-listed: Yes  No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

Rationale for request: In order to meet accreditation requirements for the Council on Education for Public Health, slight course changes are needed to identify/flag how the course meets foundational knowledge and core competency requirements.

Prepared by:

Date: 14-Dec-18

Faculty: Applied Health Science

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation

Milestone  New  Revision  Inactivation

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:

(e.g. consent, description, title, requisites) Minor modifications to description, change from credit/non-credit to numerical marking, remove antireq: HSG 609

Course Subject code: Choose an item. Course number: HLTH 617

Course Title (max. 100 characters incl. spaces): Population Intervention for Disease Prevention and Health Promotion

Course Short Title (max. 30 characters incl. spaces): Disease Prevention & Health Promotion

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:  Department

Course Description:

This course introduces the principals and methods for the effective design, selection and implementation of public health interventions to address socio-behavioural risk factors. At completion, students will be able to: determine when interventions are justified; differentiate between individual and population level interventions; describe various types of interventions; use theory and evidence to select and design interventions including the appropriate mixes of intervention types, sites, and delivery systems. Emphasis is placed on self learning through reading and problem-based learning. Lectures highlight and link important constructs, theories, perspectives, and bodies of evidence.

New course description (for revision only):

The first of two capstone courses in the MPH program, this course presents the principles and methods for the effective design, selection and implementation of public health interventions to address environmental, social, and behavioural risk factors. Students will determine when interventions are justified; differentiate between individual and population level interventions; describe various types of interventions; use theory and evidence to select and design interventions including the appropriate mixes of intervention types, sites, and delivery systems. Emphasis is placed on developing a final project that integrates methods, concepts and theories in public health through reading and problem-based learning.

Meet Type(s): Lecture Lecture Choose an item. Choose an item.

Primary Meet Type: Lecture

Requisites: Completion of core courses in the MPH program

Special topics course:                      Yes                       No

Cross-listed:                                      Yes                                       No

Course Subject(s) to be cross-listed with and approval status:

Sections combined/heldwith:

**Rationale for request:** To meet accreditation requirements we must provide a culminating experience for MPH students. In conjunction with HLTH 602B, the existing HLTH 617 course largely accomplishes this: proposed revisions flag that this is a capstone course.

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Prepared by:

Date: 14-Dec-18



**M E M O**

TO: Kathy Winter

FROM: B. Hellinga, Associate Dean, Graduate Studies  
Faculty of Engineering

RE: Senate Graduate and Research Council Agenda

DATE: April 26, 2019

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Please place the following motion forward for approval at the next meeting of SGRC. This item was approved by EFC on February 26, 2019.

1. Faculty of Engineering Calendar Updates

Your attention to these matters is kindly appreciated.

A handwritten signature in black ink, appearing to read "Bruce Hellinga".

Bruce Hellinga

BH/bm

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

**Faculty:** Engineering

**Program:**

**Program contact name(s):** Sarah Landy

**Form completed by:** Sarah Landy

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Updates to Faculty of Engineering Calendar guidelines including:*

- *General language clean up*
- *Clarification of probationary admission guidelines*
- *Formal addition of supervision guidelines previously posted on EGSO website*
- *Formal addition of course requirements previously posted on EGSO website*
- *Updates to MASc thesis committee composition guidelines*
- *Updates to PhD Comprehensive Exam guidelines*

**Is this a [major modification](#) to the program?** No

**Rationale for change(s):**

*Changes to probationary admission guidelines and addition of supervision guidelines and Faculty course requirements are to formalize Faculty regulations that are already in practice and posted on the EGSO website but not in the Graduate Studies Calendar*

*Changes to the MASc thesis committee composition guidelines and PhD Comprehensive Exam guidelines stem from the recent updates to GSPA calendar revisions in these areas and are meant to highlight where the Faculty practices differ from the University standard.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/engineering/faculty-engineering-minimum-requirements> .

<b>Current Graduate Studies Academic Calendar content:</b>	<b>Proposed Graduate Studies Academic Calendar content:</b>
The following sections describe minimum requirements for graduate programs in the Faculty of Engineering. Departments may have additional requirements and/or higher standards.	The following sections describe minimum requirements for graduate programs in the Faculty of Engineering. Departments may have additional requirements and/or higher standards.

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><b>Admission requirements</b></p> <p>For Master’s and Diploma program applicants who completed their previous relevant degree at a Canadian institution, the Faculty of Engineering requires a minimum overall average of 75% either over 4 years or a minimum overall average of 75% over the last 2 years for admission. For all other applicants, the Faculty of Engineering requires a minimum overall average of 75% over 4 years in the applicant’s previous relevant program for admission.</p> <p>For PhD and Non-degree program applicants the Faculty of Engineering requires a minimum overall average of 75% in the applicant’s previous relevant program for admission. Some departments and programs have additional requirements and/or require a higher admission average.</p> <p>Applicants to Master’s or Diploma programs who do not meet the required minimum overall average may be considered for probationary admission if they meet at least one of the following conditions:</p> <ol style="list-style-type: none"> <li>1. A minimum of 78% average in the last year of their bachelor’s program (including all credit courses);</li> <li>2. At least three years of relevant industrial or professional experience following the completion of a bachelor’s degree.</li> </ol> <p>The minimum overall degree requirements for probationary students are identical to those of regular students. However, probationary students may be required to complete undergraduate or graduate courses additional to those required of regular Master's students. In addition, at least the first two courses of a probationary student's program should be specified in writing at the time of departmental recommendation for admission. The student will need to achieve a minimum grade of 75% (Departments may specify a higher minimum grade in the offer letter) in each course in order to continue in the Master's program as regular students. If the student fails to achieve the required grades their status must be reviewed by the Department Graduate Studies Committee. Normally a student will not continue on probationary status for more than two terms.</p>	<p><b>Admission requirements</b></p> <p>For Master’s and Diploma program applicants who completed their previous relevant degree at a Canadian institution, the Faculty of Engineering requires a minimum overall average of 75% either over 4 years or a minimum overall average of 75% over the last 2 years for admission. For all other applicants, the Faculty of Engineering requires a minimum overall average of 75% over 4 years in the applicant’s previous relevant program for admission.</p> <p>For PhD and Non-degree program applicants the Faculty of Engineering requires <u>the University standard of</u> a minimum overall average of 75% in the applicant’s previous relevant program for admission. Some departments and programs have additional requirements and/or require a higher admission average.</p> <p>Applicants to Master’s or Diploma programs who do not meet the required minimum overall average may be considered for probationary admission if they meet at least one of the following conditions:</p> <ol style="list-style-type: none"> <li>1. A minimum of 78% average in the last year of their bachelor’s program (including all credit courses);</li> <li>2. At least three years of relevant industrial or professional experience following the completion of a bachelor’s degree.</li> </ol> <p>The minimum overall degree requirements for probationary students are identical to those of regular students. However, probationary students may be required to complete undergraduate or graduate courses additional to those required of regular Master's students. In addition, at least the first two courses of a probationary student's program should be specified in writing at the time of departmental recommendation for admission. <u>These courses should not be taught by the student’s supervisor and</u> the student will need to achieve a minimum grade of 75% (Departments may specify a higher minimum grade in the offer letter) in each course in order to continue in the Master's program as regular students. If the student fails to achieve the required grades their status must be reviewed by the Department Graduate Studies Committee. Normally a student will not continue on probationary status for more than two terms. <u>A student</u></p>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>Probationary admission is not permitted for Doctoral programs.</p> <h2>Course requirements</h2> <h3>Course grades</h3> <p>A grade of less than 65% in any graduate course offered within the Faculty of Engineering is considered a failed course. Students in the Faculty of Engineering are required to maintain a cumulative program average of at least 70% to remain in their program. Some programs may have higher required grades and cumulative averages.</p> <p>If a student fails a course, or their average falls below their program's required minimum, they will automatically undergo a formal academic review by the Graduate Studies Committee within their Department. <del>One outcome of the formal academic review is that the student will be required to withdraw from their program.</del></p> <h3>Maximum number of courses taken per term</h3> <p>There is a maximum number of courses in which students registered in the Faculty of Engineering may enroll each term. This maximum applies to both course- and thesis-based students, in both the Master's and PhD programs.</p> <p>Full-time students may enroll in a maximum of <del>5 courses (total of 2.5 credits)</del> per term, except in the MArch program within the School of Architecture where a maximum of 6 courses (total of 3.0 credits) is permitted.</p> <p>Part-time students may enroll in a maximum of <del>2 courses (total of 1 credit)</del> per term.</p> <p>Departments may impose lower maximum values for specific programs. Program specific requirements can be found in the relevant sections of this calendar. It is the student's responsibility to become aware of requirements associated with their specific program.</p> <p>In exceptional circumstance, full-time students may request to register in an additional course, but this must be approved by the course instructor, the Associate</p>	<p><u>cannot go inactive until their probationary requirements have been cleared.</u></p> <p>Probationary admission is not permitted for Doctoral programs.</p> <h2>Course requirements</h2> <p><u>At least half of the courses for the minimum degree requirements must normally be Faculty of Engineering Graduate Courses.</u></p> <h3>Course grades</h3> <p>A grade of less than 65% in any graduate course offered within the Faculty of Engineering is considered a failed course. Students in the Faculty of Engineering are required to maintain a cumulative program average of at least 70% to remain in their program. Some programs may have higher required grades and cumulative averages.</p> <p>If a student fails a course, or their average falls below their program's required minimum, they will automatically undergo a formal academic review by the Graduate Studies Committee within their Department. <u>The outcome of this review will either be (i) a decision to permit the student to remain in the program which will normally also include placing the student on Academic Probation and declaring how and when the student must clear the probationary conditions; or (ii) recommending to the Associate Dean that the student be required to withdraw from the program.</u></p> <h3>Maximum number of courses taken per term</h3> <p>There is a maximum number of courses in which students registered in the Faculty of Engineering may enroll each term. This maximum applies to both course- and thesis-based students, in both the Master's and PhD programs.</p> <p>Full-time students may enroll in a maximum of <u>1.75 credits of courses (typical full term graduate courses have 0.5 credits, implying a maximum of three 0.5 weight courses)</u> per term, except <u>students in the MArch program within the School of Architecture who (due to differences in course weights), may enroll in a</u></p>

<b>Current Graduate Studies Academic Calendar content:</b>	<b>Proposed Graduate Studies Academic Calendar content:</b>
<p>Chair for Graduate Studies, and the Associate Dean for Graduate Studies using the <a href="#">Graduate studies course drop/add form</a>.</p> <p><b><del>Comprehensive exam milestone</del></b></p> <p>PhD students in the Faculty of Engineering are required to successfully complete the PhD Comprehensive Exam milestone.</p> <p>The <a href="#">PhD Comprehensive Examination</a> consists of an oral examination conducted at the University of Waterloo with the candidate and members of the Comprehensive Examining Committee present. <del>The examination consists of the following two parts:</del></p> <ul style="list-style-type: none"> <li><del>• an examination of the research proposal that the candidate intends to develop into a successful PhD research thesis,</del></li> <li><del>• an examination of the breadth of the candidate's knowledge of the academic field of the thesis and the adequacy of the candidate's background preparation to pursue the proposed research.</del></li> </ul> <p><b>Proposal requirements</b></p> <p>The research proposal will consist of a double spaced report of no more than 50 pages including tables, diagrams, and references.</p> <p>The proposal should:</p> <ol style="list-style-type: none"> <li>1. identify the research problem,</li> <li>2. review the relevant literature,</li> <li>3. describe <del>the tasks planned to solve the problem,</del> and</li> <li>4. propose a timetable for the completion of the project, including the defense of the PhD thesis. With approval from their supervisor, a student may wish to distribute background working papers to members of the Committee to provide further evidence of background preparation.</li> </ol> <p><b>Distributing the proposal</b></p>	<p><u>maximum of 3.0 credits of courses per term. Additionally, students enrolled in the MBET program within the Conrad School of Entrepreneurship and Business will be exempt from the Faculty maximums due to differences in program structure and may only enroll in prescribed courses as per departmental procedure.</u></p> <p><u>Part-time students may enroll in a maximum 0.75 credits (e.g. one 0.5 weight course) per term. Similarly to full-time students, MArch and MBET students have alternative part-time maximums due to differences in program structure.</u></p> <p>Departments may impose lower maximum values for specific programs. Program specific requirements can be found in the relevant sections of this calendar. It is the student's responsibility to become aware of requirements associated with their specific program.</p> <p>In exceptional circumstance, full-time students may request to register in an additional course, but this must be approved by the course instructor, the Associate Chair for Graduate Studies, and the Associate Dean for Graduate Studies using the <a href="#">Graduate studies course drop/add form</a>.</p> <p><b><u>Program-specific course requirements</u></b></p> <p><u>For all thesis-based programs, the course plan is established by the student, their supervisor, and if deemed necessary, with the departmental Associate Chair, Graduate Studies.</u></p> <p><b><u>Master's Programs (including MASc, MEng, MMSc, and MArch)</u></b></p> <p><u>A minimum of two-thirds of the courses used for credit towards a Master's degree must be taken from 600 and 700 series graduate courses.</u></p> <p><u>Master's students may be permitted to take a limited number of 500 series courses (400 series in Electrical and Computer Engineering), where 500 series courses are senior undergraduate courses.</u></p> <p><b><u>Doctoral Programs</u></b></p>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p>Students must submit a copy of their proposal to each member of their committee at least two weeks before the date of the comprehensive examination.</p> <p>Departments may set additional requirements. Please check the relevant sections of this calendar for further information, or with the appropriate department authority. It is the student's responsibility to become aware of any department requirements which are in addition to the stated Faculty of Engineering minima.</p> <p><b>Comprehensive exam timeline</b></p> <p><del>Students with a Master's degree (PhD2)</del></p> <p><del>The Faculty of Engineering requires that PhD2 students complete the Comprehensive Exam by the end of term four of their PhD program.</del></p> <p><del>Students without a Master's degree entering the doctoral program directly from a Bachelor's program (PhD3)</del></p> <p><del>The Faculty of Engineering requires that PhD3 students complete the Comprehensive Exam by the end of term six of their PhD program.</del></p> <p><del>Students transferring into the doctoral program from a Master's program (PhD3-tr/PhD2-tr)</del></p> <p><del>The Faculty of Engineering requires that PhD3-tr/PhD2-tr students complete the Comprehensive Exam by the earlier of either:</del></p> <ul style="list-style-type: none"> <li><del>• four terms from the first term the student was registered in the PhD program, or</del></li> <li><del>• eight terms from the beginning of the student's Master's program.</del></li> </ul> <p>Note: in establishing the above timelines, each term of full-time enrollment counts as <del>one</del> term and each term of part-time enrollment counts as 0.5 terms.</p> <p><b>Comprehensive exam extension requests</b></p> <p><del>Students who do not complete the Comprehensive Exam milestone by the terms noted above are required to complete a PhD Comprehensive Exam Request for Time Limit Extension Form justifying the need for an</del></p>	<p><u>PhD candidates possessing a Master's degree in an appropriate discipline are required to take a minimum of three courses at the 600 or 700 level. Departments may require students to take more than three courses.</u></p> <p><u>Generally, candidates with a Master's degree cannot complete a 500-level course towards their PhD degree requirements. The inclusion of a 500 level course for credit must be recommended by the candidate's supervisor and the home department's Associate Chair, Graduate Studies prior to enrolling in the course, and it must be approved by the Associate Dean, Graduate Studies.</u></p> <p><u>PhD candidates without a completed Master's degree in an appropriate discipline are required to complete at least seven courses, of which a minimum of five must be at the 600 or 700 level. Up to two 500-level courses can be completed towards the candidate's program requirements. The inclusion of additional 500 level courses for credit must be recommended by the candidate's supervisor and the home department's Associate Chair, Graduate Studies prior to enrolling in the course, and it must be approved by the Associate Dean, Graduate Studies.</u></p> <p><u>In all cases, departments may have more restrictive policies on the types of courses that may be used for credit towards a degree.</u></p> <p><b><u>Courses taught by supervisor or co-supervisor</u></b></p> <p><u>To ensure students receive a diversity of experience in teaching methods, academic feedback, and evaluations, the Faculty of Engineering requires that at least one half of the course credits required as part of the student's program be taught by instructors other than the student's supervisor or co-supervisor(s). In the case where a student has two or more co-supervisors and there is compelling academic justification, a student can petition their Department and the Associate Dean, Graduate Studies to reduce this requirement and thereby receive credit for additional courses taught by the student's supervisors. This petition should be submitted prior to enrolling in a course for which credit is desired.</u></p>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><del>extension for completing the Comprehensive Exam milestone. Students who do not submit a request for extension, or whose extension request is not approved, may be required to withdraw from the program.</del></p> <h2>MASc Thesis acceptance and examination</h2> <p><a href="#">Master's degree with thesis</a></p> <p>In the Faculty of Engineering, the required display period for the MASc thesis is fifteen business days.</p> <p><del>Although not typically required by departments, the Associate Dean for Graduate Studies may require an oral defense if circumstances warrant it or if the department or student requests it.</del></p> <p>Departments may set additional requirements. Please check the relevant sections of this calendar for further information, or with the appropriate department authority. It is the student's responsibility to become aware of requirements which are in addition to the stated minima.</p> <h2>PhD thesis acceptance and examination</h2> <p><a href="#">PhD minimum requirements</a></p> <p>In the Faculty of Engineering, the required display period for the Doctoral thesis is twenty-five business days. External Examiners must be approved by the Associate Dean for Graduate Studies prior to the thesis being accepted for display by the Engineering Graduate Studies Office.</p> <p>Departments may set additional requirements. Please check the relevant sections of this calendar for further information, or with the appropriate department authority. It is the student's responsibility to become aware of requirements which are in addition to the stated minima.</p> <p><del>Thesis changes after defense</del></p>	<h2>MASc Thesis acceptance and examination</h2> <p><a href="#">Master's degree with thesis</a></p> <p>In the Faculty of Engineering, the required display period for the MASc thesis is fifteen business days.</p> <h3><u>MASc Thesis Committee</u></h3> <p><u>The purpose of the Thesis Committee is to evaluate the student's scholarly work which is the culmination of the research. In the Faculty of Engineering, the Thesis Committee (in some departments called the Reading Committee and in others the Examining Committee) will consist of a minimum of two examiners who are not the student's supervisor(s). The Faculty of Engineering has adopted the <a href="#">University regulations regarding committee composition</a>.</u></p> <p><u>It is the responsibility of the student's supervisor or the Departmental Graduate Officer to identify appropriate members for the Thesis Committee.</u></p> <p>Departments may set additional requirements. Please check the relevant sections of this calendar for further information, or with the appropriate department authority. It is the student's responsibility to become aware of requirements which are in addition to the stated minima.</p> <h2><u>PhD Comprehensive Examination milestone</u></h2> <p>PhD students in the Faculty of Engineering are required to successfully complete the PhD Comprehensive Examination milestone.</p> <p><u>The <a href="#">PhD Comprehensive Examination</a> consists of an oral examination conducted at the University of Waterloo with the candidate and members of the Comprehensive Examining Committee present. In the Faculty of Engineering, the examination serves to determine that PhD students have:</u></p> <ol style="list-style-type: none"> <li>1. <u>The capacity to communicate clearly in both oral and written form;</u></li> </ol>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
<p><del>The Faculty of Engineering expects students to meet the following completion deadlines depending on the outcome of their Thesis Defense.</del></p> <ul style="list-style-type: none"> <li><del>• Category 1 – 1 month</del></li> <li><del>• Category 2 – 4 months</del></li> </ul> <p><del>In exceptional circumstances, a student may be granted an exception to these deadlines. Requests for exception must be submitted in writing for approval by the supervisor(s), the Associate Chair of Graduate Studies, and the Associate Dean for Graduate Studies. Failure to meet these timelines may result in the student being required to withdraw.</del></p>	<ol style="list-style-type: none"> <li><u>2. The appropriate breadth and depth of knowledge of the field of study and the background necessary to be successful in their PhD program; and</u></li> <li><u>3. Developed a research proposal that is novel, is of the appropriate scope for a PhD, and is likely to be feasible (e.g. required resources are available; candidate has appropriate knowledge/skill, etc.).</u></li> </ol> <p><u>The format of the comprehensive examination may vary by department. In some departments, there is a single examination which addresses all three of the purposes listed above. In other departments, the PhD Comprehensive Examination is divided into two separate milestones, with the first focusing on the background preparation of the student (items 1 and 2 from the list above) and the second focusing on the research proposal (items 1 and 3 from the list above). The Comprehensive Examining Committee requirements described below do not apply to the committee for the Background Exam for Departments which have two separate milestones.</u></p> <p><b><u>Comprehensive Examining Committee</u></b></p> <p><u>In Engineering, the Comprehensive Examining Committee will consist of a minimum of three examiners (one more than the University minimum requirements) in addition to the student’s supervisor(s). These examiners must satisfy the following conditions:</u></p> <ul style="list-style-type: none"> <li><u>• must hold a PhD or equivalent degree</u></li> <li><u>• at most one can hold an adjunct appointment or emeritus status</u></li> <li><u>• at least one, in addition to the supervisor, must be from the student’s home department and hold a tenure or tenure track position;</u></li> <li><u>• at least one must be from outside the student’s home department</u></li> </ul> <p><u>It is the responsibility of the student’s supervisor to recommend appropriate members for the Examining Committee. The composition of the comprehensive examining committee will be approved by the Associate Dean, Graduate Studies for the student’s Faculty, or delegate.</u></p> <p><u>The comprehensive exam shall be chaired by a tenured or tenure-track faculty member at the University of</u></p>

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<p><u>Waterloo with Approved Doctoral Dissertation Supervision (ADDS) status, normally external to the student's home Department/School. The Chair is a non-voting member of the comprehensive examining committee.</u></p> <p><b><u>Research Proposal requirements</u></b></p> <p>The research proposal will consist of a double spaced report of no more than 50 pages including tables, diagrams, and references.</p> <p>The proposal should:</p> <ol style="list-style-type: none"> <li>1. identify the research problem,</li> <li>2. review the relevant literature,</li> <li>3. describe the <u>approach that is proposed to solve the problem and how this approach and/or the expected outcomes are novel</u></li> <li>4. <u>identify resources (e.g. data, equipment, space, etc) that will be needed to carry out the research and how these resources have been or will be acquired, and</u></li> <li>5. propose a timetable for the completion of the project, including the defense of the PhD thesis. With approval from their supervisor, a student may wish to distribute background working papers to members of the Committee to provide further evidence of background preparation.</li> </ol> <p><u>As per <a href="#">University regulations</a>, students are required to ensure that the research proposal does not violate academic integrity, including plagiarism.</u></p> <p><b>Distributing the proposal</b></p> <p>Students must submit a copy of their proposal to each member of their committee at least 10 business days before the date of the comprehensive examination.</p> <p>Departments may set additional requirements. Please check the relevant sections of this calendar for further information, or with the appropriate department authority. It is the student's responsibility to become aware of any department requirements which are in addition to the stated Faculty of Engineering minima.</p> <p><b>Comprehensive Examination timeline</b></p>

**Current Graduate Studies Academic Calendar content:**

**Proposed Graduate Studies Academic Calendar content:**

Students enrolled in a PhD program in the Faculty of Engineering must complete their Comprehensive Examination by the end of the term specified below. Note that all students, regardless of PhD program, must have their Comprehensive Examination complete before the end of their 7<sup>th</sup> term of enrolment otherwise they will be required to withdraw from their program.

<u><b>Program</b></u>	<u><b>Comprehensive Examination must be completed before the end of</b></u>
<u>Students with a Master's degree (PhD2)</u>	<u>4<sup>th</sup> term</u>
<u>Students admitted directly to PhD from the Bachelor's degree (PhD3)</u>	<u>6<sup>th</sup> term</u>
<u>Students who transfer to PhD without completing Master's degree and who do not hold a Master's degree (PhD3 transfer)</u>	<u>the earlier of either:</u> <ul style="list-style-type: none"> <li>• <u>four terms from the first term the student was registered in the PhD program, or</u></li> <li>• <u>six terms from the beginning of the student's Master's program</u></li> </ul>

Note: in establishing the above timelines, each term of full-time enrollment counts as 1.0 term and each term of part-time enrollment counts as 0.5 terms.

**Comprehensive Examination extension requests**

The Faculty of Engineering adheres to the [University's regulations](#) with respect to petitions for extensions to the above stated examination deadlines.

**PhD thesis acceptance and examination**

[PhD minimum requirements](#)

In the Faculty of Engineering, the required display period for the Doctoral thesis is twenty-five business

Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
	<p>days. External Examiners must be approved by the Associate Dean for Graduate Studies prior to the thesis being accepted for display by the Engineering Graduate Studies Office.</p> <p>Departments may set additional requirements. Please check the relevant sections of this calendar for further information, or with the appropriate department authority. It is the student's responsibility to become aware of requirements which are in addition to the stated minima.</p>

**How will students currently registered in the program be impacted by these changes?**

*The proposed calendar changes primarily reflect existing requirements/practices that have either not be captured in the calendar and/or required clarification. Consequently, students admitted prior to Spring 2019 will be required to abide by the above listed faculty guidelines. If the student can provide sufficient information to demonstrate that one of the changes stated above is sufficiently different from the degree requirements stated in the Graduate Studies Academic Calendar or supplemental material provided by the Faculty/Department at the time of their admission that it is of detriment to their progression through their program a waiver of these requirements can be approved by the Associate Dean, Graduate Studies.*

**EGSC approval date** (mm/dd/yy): 12/12/18

**Reviewed by GSO** (for GSO use only)  date (mm/dd/yy): 01/16/19

**Faculty approval date** (mm/dd/yy):

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

**Faculty of Mathematics**  
**Report to Senate Graduate and Research Council**  
**April 29, 2019**

Attached are the motions that have been approved by the Mathematics Faculty Council on April 16, 2019, and now require approval by Senate Graduate Research Council (SGRC)

Please place the following motions on the agenda for the next Senate Graduate and Research Council meeting:

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**Motion from Applied Mathematics**

1. Change the English Language Proficiency requirements for Master's and PhD programs in Applied Mathematics, from those listed in "Graduate Studies accepted examinations and alternative higher scores" to "Graduate Studies accepted examinations and required scores" in the Graduate Calendar.

**Motions from Statistics and Actuarial Science**

**2.1 Motion:** Change the description of the PhD comprehensive examination I in graduate calendar for the PhD in Statistics and the PhD in Biostatistics: remove comprehensive written exams, remove STAT 901 and STAT 908 as required courses; enforce that 3 courses be taken from Category Table to meet breadth requirement; make STAT 900 a required course

**2.2 Motion:** Change the description of the PhD comprehensive examination I in graduate calendar for the PhD in Actuarial Science. Remove comprehensive written exams, remove STAT 850 and STAT 901 as required courses; enforce that 3 courses be taken from Category Table to meet breadth requirement; make ACTSC 900 a required course.

**2.3 Motion:** Create new course ACTSC/STAT 900 "PhD Research Skills"

**Rationale for Motions 2.1-2.3:** The Department has determined over a number of discussions in the last two years that the Part 1 Comprehensive Examinations are not doing a good job of evaluating the students and are having an unforeseen consequence of slowing down research progress. Hence these exams are being replaced by using instead a well-defined breadth requirement and a new required course to learn research skills.

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies and Postdoctoral Affairs (GSPA).

**Faculty:** Mathematics

- Program:**
- 1) Doctor of Philosophy (PhD) in Applied Mathematics
  - 2) Doctor of Philosophy (PhD) in Applied Mathematics - Quantum Information
  - 3) Doctor of Philosophy (PhD) in Applied Mathematics - Water
  - 4) Master of Mathematics (MMath) in Applied Mathematics
  - 5) Master of Mathematics (MMath) in Applied Mathematics - Co-operative Program
  - 6) Master of Mathematics (MMath) in Applied Mathematics - Quantum Information
  - 7) Master of Mathematics (MMath) in Applied Mathematics - Water

**Program contact name(s):** Lilia Krivodonova

**Form completed by:**

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Changing the required English language proficiency (ELP) score from the alternative higher scores to the regular/standard required scores.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*To align the department's language requirements with the university-wide requirements.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/general-information-and-regulations/english-language-proficiency>

<b>Current Graduate Studies Academic Calendar content:</b>	<b>Proposed Graduate Studies Academic Calendar content:</b>
<del>Graduate Studies accepted examinations and alternative higher scores</del>	<u>Graduate Studies accepted examinations and required scores</u>

Current Graduate Studies Academic Calendar content:						Proposed Graduate Studies Academic Calendar content:					
<u>Internet-based TOEFL (iBT)</u>	<u>IELTS (Academic)</u>	<u>MELAB</u>	<u>CAEL</u>	<u>PTE (Academic)</u>	<u>EFAS</u>	<u>Internet-based TOEFL (iBT)</u>	<u>IELTS (Academic)</u>	<u>MELAB</u>	<u>CAEL</u>	<u>PTE (Academic)</u>	<u>EFAS</u>
100; writing 26; speaking 26	7.5; writing 7.0; speaking 7.0	90; 80 per section; speaking 3	70; 60 per band; 70 writing; 70 speaking	68; writing 65; speaking 65	80% overall in level 400 with at least 75% in writing, oral and academic skills	90; writing 25; speaking 25	7.0; writing 6.5; speaking 6.5	85; 80 per section; speaking 3	70; 60 per band; 70 writing; 70 speaking	63; writing 65; speaking 65	75% overall in level 400 with at least 75% in writing, oral and academic skills

**How will applicants to the program be impacted by these changes?**

*More applicants will be eligible to apply to the program.*

**Department/School approval date (03/05/19):**

**Reviewed by GSPA (for GSPA use only)  date (mm/dd/yy):**

**Faculty approval date (04/16/19):**

**Senate Graduate & Research Council (SGRC) approval date (mm/dd/yy):**

**Senate approval date (mm/dd/yy) (if applicable):**

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

**Faculty:** Mathematics

**Program:** 1) Doctor of Philosophy (PhD) in Statistics  
2) Doctor of Philosophy (PhD) in Statistics - Biostatistics

**Program contact name(s):** Mary Lou Dufton

**Form completed by:** Mary Lou Dufton

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Changing Part 1 of the PhD Comprehensive Examination to a breadth requirement and as a result updating the course requirements and required overall average.*

**Is this a [major modification](#) to the program?** No

**Rationale for change(s):**

*It has been felt for some time that the Part 1 comprehensive exams are not doing a good job of evaluating the students and are having an unforeseen consequence of slowing down research progress. Having a well-defined breadth requirement is aimed to solve these problems.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/mathematics/department-statistics-and-actuarial-science/doctor-philosophy-phd-statistics>

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Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:
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Current Graduate Studies Academic Calendar content:	Proposed Graduate Studies Academic Calendar content:								
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**How will students currently registered in the program be impacted by these changes?**

*There will be no effect as they will have taken the old exam already.*

**Departmental approval date** (mm/dd/yy): 03/08/2019

**Reviewed by GSO** (for GSO use only)  date (mm/dd/yy): 03/21/2019

**Faculty approval date** (04/16/19):

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Prior to form submission, review the [content revision instructions](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

**Faculty:** Mathematics

**Program:** Doctor of Philosophy (PhD) in Actuarial Science

**Program contact name(s):** Mary Lou Dufton

**Form completed by:** Mary Lou Dufton

**Description of proposed changes:**

Note: changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form ([PC docx version](#) or [MAC docx version](#)).

*Changing Part 1 of the PhD Comprehensive Examination to a breadth requirement and as a result updating the course requirements and required overall average.*

Is this a [major modification](#) to the program? No

**Rationale for change(s):**

*It has been felt for some time that the Part 1 Comprehensive Examinations are not doing a good job of evaluating the students and are having an unforeseen consequence of slowing down research progress. Having a well-defined breadth requirement is aimed to solve these problems.*

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**How will students currently registered in the program be impacted by these changes?**

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**Faculty approval date** (04/16/19):

**Senate Graduate & Research Council (SGRC) approval date** (mm/dd/yy):

**Senate approval date** (mm/dd/yy) (if applicable):

Faculty: Math

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation Milestone  New  Revision  Inactivation 

New milestone title: Choose an item.

For course revisions, indicate the type(s) of changes:  
(e.g. consent, description, title, requisites)

Course Subject code: STAT Course number: 900

Course Title (max. 100 characters incl. spaces): PhD Research Skills

Course Short Title (max. 30 characters incl. spaces): PhD Research Skills

Grading Basis: NUMERICAL

Course Credit Weight: 0.50

Course Consent Required:  Department

## Course Description:

This course acts as a capstone on the coursework based part of the PhD program and as a stepping stone to the PhD proposal and to research. It is aimed at developing research skills: critically reading published research, summarizing and synthesizing areas of research, writing and orally presenting summaries of research problems, data sets and theoretical and applied results. The course is designed to be integrative across core areas of the student discipline.

## New course description (for revision only):

Meet Type(s): Lecture Choose an item. Choose an item. Choose an item.

Primary Meet Type: Lecture

[Requisites:](#)Special topics course: Yes  No Cross-listed: Yes  No 

Course Subject(s) to be cross-listed with and approval status: ACTSC 900 (approved by the SAS Department)

Sections combined/heldwith:

Rationale for request: This course aims to prepare PhD students with the skills needed to move forward with their research.

Prepared by: Mary Lou Dufton

Date: 11-Mar-19

Faculty: Math

Effective term: Term/Year Fall 2019

Course  New  Revision  Inactivation Milestone  New  Revision  Inactivation 

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Sections combined/heldwith:

Rationale for request: This course aims to prepare PhD students with the skills needed to move forward with their research.

Prepared by: Mary Lou Dufton

Date: 11-Mar-19

May 6, 2019

TO: Kathy Winter, Privacy Officer and Assistant University Secretary,  
Senate Graduate and Research Council

FROM: Jeff Casello, Associate Vice-President, Graduate Studies and Postdoctoral

Affairs RE: Graduate Studies Academic Calendar changes

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**Items for approval:**

- 1) Clarifying the add / drop regulations for graduate students.

**Description and rationale for proposed changes:**

*Changes to the course drop protocol for graduate studies are being proposed to provide clarity and consistency in the process. The motivation is to provide students with ample time to evaluate a course such that the add / drop decision can be made without a record. Students who proceed with a course beyond the drop period, but withdraw from the course will have their participation recorded as a grade of withdrawn (WD) on the student record. Note that WD is not an academic penalty.*

**Proposed effective date:** Term: Fall Year: 2019

**Current [Graduate Studies Academic Calendar \(GSAC\)](#) page** (include the link to the web page where the changes are to be made):

<https://uwaterloo.ca/graduate-studies-academic-calendar/general-information-and-regulations/enrolment-and-time-limits>

<b>Current Graduate Studies Academic Calendar content:</b>	<b>Proposed Graduate Studies Academic Calendar content:</b>
<p><b>Course drop/add date</b></p> <p><del>During the first three weeks of term, students must drop or add graduate courses using Quest, the University of Waterloo's online student information system. For courses with enrolment restrictions, students must obtain permission through their Department Graduate Assistant.</del></p> <p>Graduate students who wish to enrol in an undergraduate course may petition using a Drop/Add form, obtainable through their Department or Graduate Studies and Postdoctoral Affairs (GSPA). Signature of the instructor, supervisor and Department Graduate Officer are required.</p>	<p><b>Course drop/add date</b></p> <p><u>Students can enroll in courses until the end of the third week of classes. Students who drop a course prior to the completion of third week of classes will have no record of that course on their transcript.</u></p> <p><u>Students who drop a course in the period between the fourth and tenth week of classes will have a record of the course on their transcript and a grade of withdrawn (WD).</u></p> <p><u>After the tenth week of classes, students may not drop or add a course except by petition using the Drop/Add form, and only under exceptional circumstances with the signature of the instructor, supervisor, Department Graduate</u></p>

<b>Current Graduate Studies Academic Calendar content:</b>	<b>Proposed Graduate Studies Academic Calendar content:</b>
<p><del>After the first three weeks of term, students may not drop or add a course except by petition using the Drop/Add form, and only under exceptional circumstances with the signature of the instructor, supervisor, Department Graduate Officer and the Associate Dean (Graduate Studies) of their home Faculty.</del></p> <p>These are Graduate Studies and Postdoctoral Affairs (GSPA) deadlines. Individual Faculties may have earlier deadlines. (Please check with your Associate Dean's Office.)</p> <p><del>Courses may not be dropped or added, nor course status changed, after the examination period begins.</del></p>	<p>Officer and the Associate Dean (Graduate Studies) of their home Faculty.</p> <p><u>Comparable dates will be used for courses with non-traditional meeting schedules.</u></p> <p>For courses with enrolment restrictions, students must obtain permission through their Department Graduate <u>Coordinator</u>.</p> <p>Graduate students who wish to enrol in an undergraduate course may petition using a Drop/Add form, obtainable through their Department or Graduate Studies and Postdoctoral Affairs (GSPA). Signature of the instructor, supervisor and Department Graduate Officer are required.</p> <p>These are Graduate Studies and Postdoctoral Affairs (GSPA) deadlines. Individual Faculties may have earlier deadlines. (Please check with your Associate Dean's Office.)</p>

**Graduate Operations Committee approval date (mm/dd/yy): 04/23/2019**

# **WATERLOO**

## **GRADUATE STUDIES**

### **MEMORANDUM**

April 29, 2019

TO: Kathy Winter, Privacy Officer and Assistant University Secretary, Senate Graduate and Research Council

FROM: Heidi Mussar, Associate Director, Graduate Financial Aid & Awards

RE: **Agenda items for Senate Graduate & Research Council – May 2019**

#### **Items for Approval**

**a) Dean of Mathematics Excellence Scholarship – operating**

An entrance scholarship, valued at \$8,000, will be awarded to new eligible students admitted to a graduate program in the Faculty of Mathematics in Spring 2019, Fall 2019 or Winter 2020. Each department may select a maximum of one recipient for the award in 2019/2020. Selection will be based on the candidate's application for admission; candidates must have a minimum cumulative average in their last completed program of at least 85% and demonstrated potential for research. Preference will be given to students admitted into a doctoral program; however, if the department cannot find a suitable doctoral candidate, they may award it to a student entering their research-based master's program.

The scholarship is being supported through operating funds within the Faculty of Mathematics. It will not be advertised in the GSPA awards database as it is intended that this award will only be for the 2019/2020 year. If the Faculty decides it should continue, then it will be added.

**b) Science Graduate Award (SGA) – operating**

Awards, valued at a minimum of \$4,500 per year, are available to support eligible graduate students registered full time in a research-based master's or doctoral program in the Faculty of Science. Students are automatically considered for this award throughout their eligibility period and may be nominated, without the need for application, by their programs to the Associate Dean of Science, Graduate Studies.

#### **Items for Information**

**c) School of Pharmacy Annual Graduate Awards – operating**

Previously approved at SG&RC in September 2016, the School of Pharmacy would like to make the following changes to the award terms for the 2019/2020 cohort of recipients:

- Removing the "Best Thesis Defence in the Pharmacy Graduate Program" category as there are similar awards available at the University and Faculty levels.
- Changing the value of the four remaining awards from \$200 to \$250; the total dollar value of the awards will remain at \$1,000.
- Changing the time period in which selection of recipients will be made; selection will now be made in April instead of March.
- All other criteria in the original terms remain.

**d) Master of Environment and Business Award – operating**

The Master of Environment and Business program would like to amend the terms of reference in regards to who makes the final selection of recipients. The current terms indicate the MEB Program Director will do so; this is being replaced by the Director of SEED.

**e) Bruce Mitchell Graduate Scholarship – endowment**

Originally established in 2016, then updated in 2016 and in 2018, the award is again being amended so that the Department of Geography and Environmental Management will select recipients based on eligible students submitting a one-page statement outlining how their research topic connects to the general theme of Environment and Resource Management to the department annually in January, instead of *automatically* identifying candidates and selecting recipients.

The timing of selection of recipients is also changing from the fall to the winter term.

All other elements of the scholarship remain unchanged.

**f) Marie Curie Graduate Student Award – operating**

Previously approved at SGRC in November 2013, the Faculty would like to make the following amendments:

**Value of the Award:**

**Current**

The award value is normally up to \$6,000 for doctoral and master's students; the goal was that the value allow for the student's resources to reach minimal cost of living, after taking into consideration their internal and external funding; the award was also meant as a mechanism to contribute to the departmental matching portion for external awards as well as to assist international master's students in paying differential tuition fees.

**Proposed**

This award will be administered in conjunction with the Science Graduate Award (SGA), recognizing Physics and Astronomy's unique recruitment needs in alignment with departmental strategic objectives. Within the context of overall funding for Physics and Astronomy graduate students, the award is granted to a selected group of students. The amount awarded per student is variable to a maximum of \$20,000 annually. Number of awards granted is constrained by the annual operating budget for this award provided by the Dean of Science, and value of awards provided to the recipients.

**Awards Description:**

**Current**

The goal of this award is to support graduate students registered full-time in the Department of Physics and Astronomy, Faculty of Science, who are engaged in research-based programs and who have a minimum cumulative average of 80%. Students must be within the first 12 terms of a doctoral program (extended to 15 terms if admitted from a bachelor's degree), or within the first 6 terms of a thesis-based master's program. Master's students who transfer to doctoral studies after term 3.0 will have an additional 12 terms of support. If the transfer occurs later than term 4.0, the funding through this award will not extend beyond a total of 15 terms.

**Proposed**

The Marie Curie Graduate Student Award, valued at a maximum of \$20,000 per year, is available to graduate students registered full-time in a research-based master's or doctoral program in the Department of Physics and Astronomy, Faculty of Science. Students are automatically considered for this award throughout their eligibility period and nominated, without the need for application, by their programs to the Graduate Committee, Department of Physics and Astronomy.