PART-5 PERFORMANCE MEASUREMENT PLAN

Preface: GWF has implemented a performance measurement strategy and timeline to track program progression and ensure that commitments are met (see *Section f* of the *Institutional Strategy progress report* for details). GWF is focussing on the year-four mid-point and year-seven end-point to assess progress across its 12 Transdisciplinary (User Question-led) projects, 21 Transformative Science (Big Data and Decision Support Tools) projects, 6 Indigenous Community co-led water research projects and 6 core teams that are producing scientific outcomes.

a) Evidence of Global Research Excellence

By mid-point (Sept 2016 – March 2020), GWF investigators **led 128 international research programs** and committees (*Figure 5.1*). Some notable achievements include: the inception of GWF as one of three Regional Hydroclimate Projects of the Global Energy and Water Exchanges (GEWEX) project of the World Climate Research Programme (WCRP); GWF leading the International Network for Alpine Research Catchment Hydrology (INARCH) on behalf of WCRP GEWEX and UNESCO's International Hydrological Programme; the establishment of GWF as the Canadian node for the Sustainable Water Futures Program of Future Earth; and the recent approval of GWF as a contributing organization to the World Meteorological Organisation (WMO).

Global Research Excellence	2016 - 2020	Year 4 Target	Year 7 Target	Status
Number of international research programs and committee where GWF members are lead investigators and/or advisors. (*see Appendix H*)	128	4	10	Exceeding
Number of prestigious international, national and institutional awards, recognitions from professional societies, and national scholarships and fellowships. (*see Appendix I*)	182	100	200	Exceeding
Global leader in science impact - quality of research – rank in h-index (as per Web of Science on Oct 14, 2020 over last 5 years)	4	2	1	Approaching
Global leader in science dissemination – rank in number of peer reviewed journal articles (as per Web of Science on Oct 14, 2020 over last 5 years)	1	1	1	Meeting
Number of presentations at international and national conferences (*see Appendix D*)	1384	500	1000	Exceeding
Number of international and national plenary, key note and invited speaking engagements (*see Appendix D*)	454	130	200	Exceeding
Number of international visiting fellows (*see Appendix J*)	24	120	200	Below
Number of international joint faculty appointments (*see Appendix K*)	29	50	100	Below
Level of cash and in-kind research funding brought by GWF Projects from national and international governments, industries, communities, and non-governmental organizations (*see Tables 7-9*)	$223M	$250M	$450M	Below

Figure 5.1: Evidence of Global Research Excellence

Between Sept 2016 and March 2020, GWF members produced **786 publications**, including 610 peer-reviewed international journal articles, 33 conference proceedings, 22 books and book chapters, and 125 non-refereed articles and datasets related to their GWF research. Of the peer-reviewed publications, 49.5% were co-authored with other countries and regions (*Data Source: SCOPUS SciVal*). The distribution of publications by subject area is represented in *Figure 5.2*. In addition, 17% of the publications were among the top 10% most cited articles worldwide, and 53.2% were published in the top 10% of journals (*Data Source: SCOPUS SciVal*).

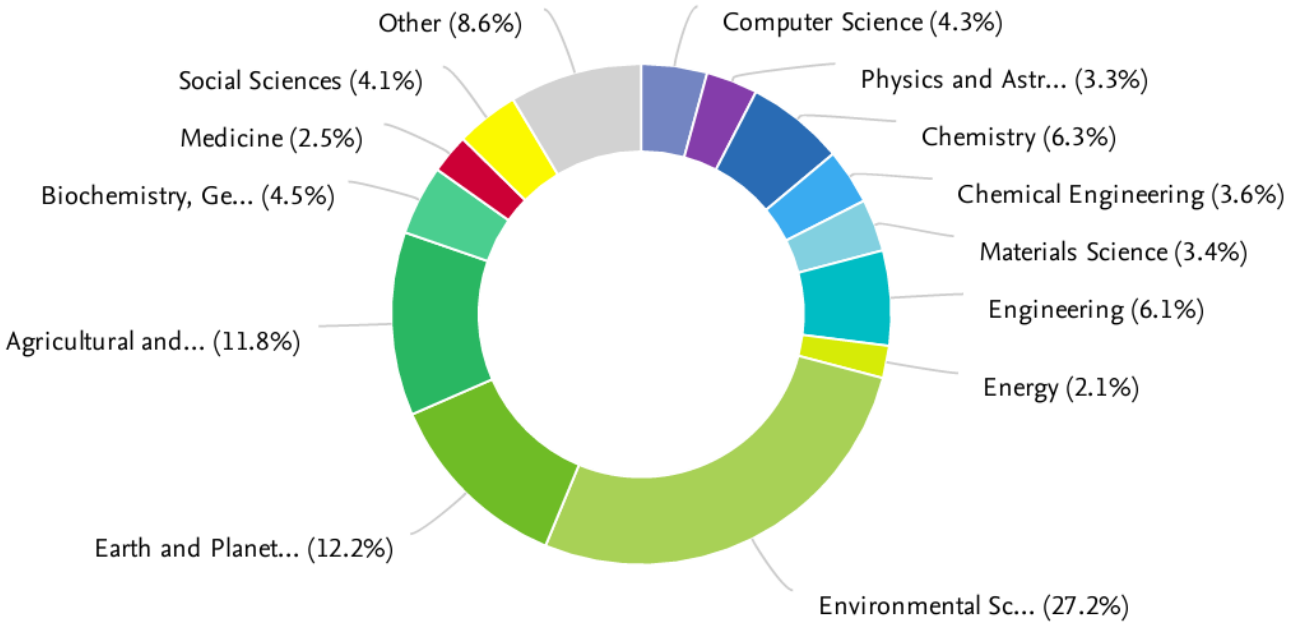

Figure 5.2: Distribution of peer reviewed publications by subject area (Data Source: SCOPUS SciVal)

The Field-Weighted Citation Impact (FWCI) of GWF publications to date is 1.54[1] indicating that these publications have been cited 54% more times than expected in the subject fields.

GWF researchers also delivered **1848 presentations, seminars and lectures** including 1384 conferences presentations and 464 invited, plenary, and keynote lectures. In addition, **230 GWF students and trainees took up professional positions** in industry, government, and academia and 141 graduate and undergraduate theses were completed.

Members of GWF have been recognized globally, nationally, and locally for their research excellence with a total of **182 awards**. Of these, almost 41% were prestigious international (27) and national (47) awards and recognitions from professional societies (*see Appendix I*).

A significant effort has been placed on leveraging opportunities to grow the GWF program. Consequently, significant cash and in-kind support has been secured from national and international governments, industries, communities, and non-governmental organizations. As of March 31, 2020, GWF *has leveraged $130.2 million in cash and formal in-kind contributions from the four partner universities and other public*

[1] FWCI is the ratio of the total citations actually received by the denominator's output, and the total citations that would be expected based on the average of the subject field (*SCOPUS SCiVal*). A FWCI of greater than 1.00 indicates that the publications have been cited more than would be expected based on the world average for similar publications.

sector, Communities, NGO and industry partners to supplement its $77.84 million grant from CFREF. In addition, there has been historical data sets contributed with an estimated value of $73.3 million. That is further enhanced by an additional $20 million in tri-agency, CFI and other federal funding, providing total resources to support research in excess of $301 million.

b) Attracting and Retaining the Best and Brightest Talent

GWF has been extremely successful in attracting, recruiting, retaining, and training the best and brightest talent as evident from the summary provided in *Figure 5.3*. As part of the GWF program, the partner institutions committed to recruiting 20 new faculty members through institutional contributions to the program. So far, the institutions have recruited 16 new and exceptionally talented and productive faculty members at various career stages for GWF. Recruitment for the remaining three positions is in progress. The new faculty members are:

1. Famiglietti, James, Canada 150 Research Chair in Hydrology and Remote Sensing and Executive Director GIWS, USask
2. Clark, Martyn, Professor, Cold Regions Hydrological Processes, USask
3. Jarvie, Helen, Professor, Water and Global Environmental Change, UWaterloo
4. Kidd, Karen, Professor and Stephen A. Jarislowsky Chair in Environment and Health, McMaster
5. Munkittrick, Kelly, Professor and Executive Director of Cold Regions and Water Science Initiatives, Wilfrid Laurier
6. Schuster-Wallace, Corinne, Associate Professor, Water and Health, USask
7. Randy Stotler, Associate Professor, Water Resource Sustainability, Hydrogeology, and Isotope Geochemistry, UWaterloo
8. Brinkmann, Markus, Assistant Professor, Exposure and Risk Management Modelling, USask
9. Brookfield, Andrea, Assistant Professor, Integrated Hydrologic Systems, UWaterloo
10. Gonsamo, Alemu, Assistant Professor in Remote Sensing, McMaster
11. Gray, Derek, Assistant Professor, Freshwater Ecology, Wilfrid Laurier
12. Kheyrollah Pour, Homa, Assistant Professor and Canada Research Chair in Remote Sensing of Environmental Change, Wilfrid Laurier
13. Lloyd Smith, Patrick, Assistant Professor, Socio-economics, USask
14. Papalexiou, Simon, Assistant Professor, Statistical Hydrology and Stochastic Processes, USask
15. Whitfield, Colin, Assistant Professor, Water Quality Modelling, USask
16. Rezanezhad, Fereidoun, Research Associate Professor, Fate of carbon, nutrients and contaminants, and biogeochemical fluxes, UWaterloo

In addition, the partner institutions have recruited other faculty in various areas of water security, including the following:

1. Creed, Irena, Professor and Associate Vice-President Research, Ecosystem Science, Ecosystem Services and Global Change, USask
2. McMartin, Dena, Professor and Associate Provost, Institutional Planning and Assessment, Watershed Management, Water Quality, Oilsands Tailings Waters, Climate Extremes USask
3. Kahan, Tara, Associate Professor, Aquatic/ Ice Chemistry, USask
4. Abdelrasoul, Amira, Assistant Professor, Membrane Science and Nanotechnology for Energy & Water Sustainability, USask
5. Bradford, Lori, Assistant Professor, Indigenous Water Knowledge, Water Policy, Water Empathy, Social Determinants of Health and Engaged Scholarship, USask
6. Strickert, Graham, Assistant Professor, Human Dimensions of Water Security, USask

GWF has so far supported and included in the program a total of **965 highly qualified personnel (HQP)**, including 167 undergraduate students, 214 master's students, 171 doctoral students, 114 postdoctoral fellows, 58 professional research associates, 30 research scientists, 70 technicians, 24 visiting fellows/professors, 63 research assistants and engineers, and 55 others *(see Table 4 for details*). These personnel are actively supervised by **189 funded faculty members from 18 Canadian Universities**. Opportunities for HQP to extend knowledge and skills include leadership workshops, special seminars (e.g. Microsatellite mission design webinar, Geospatial Intelligence, Critical Zone Observatory, freezing precipitation and wet snow, Impacts of forest disturbances and climate change on watershed hydrology and biogeochemistry, Ecological risk assessment of pesticides in the Prairie Pothole Region), short courses (e.g. Principles of Hydrology, Environmental Models and Bayesian Inference, CREATE Professional Practice in Water Security, Winter Precipitation, Environmental Effects Monitoring, Changing Weather Extremes) and transdisciplinary boot camps (e.g. NSERC CREATE in Water Security program, R+GitHub Recurring Workshop on data management and visualization, role of Indigenous communities and governments in environmental management and monitoring, workshop in mitigation and adaptation to climate change impacts) the total number of which exceed expectations at this stage in the program. Particular emphasis has been placed on professional development and career advancement of early career researchers such as the Distinguished Lecture Series, Women and Water Lecture Series, Future Professoriate, Writing for The Conversation, Isotope Tracers in Catchment Hydrology, KM Webinars, and Data Management Webinars. The talent and training excellence achieved by the students and postdoctoral fellows at GWF can be assessed by the number of honours and awards received. Between Sept 2016 and March 2020, **of 499 graduate students and postdoctoral fellows, 46% held major awards and recognitions**, such as Queen Elizabeth Scholarship, Queen Elizabeth II Centennial Aboriginal Scholarship, Natural Science and Engineering Research Council of Canada (NSERC) Canada Graduate Scholarship, NSERC Post Graduate Scholarship for Doctoral and Masters, NSERC Vanier Canada Graduate Scholarship, and NSERC Alexander Graham Bell Canada Graduate Scholarship.

Attracting and Retaining the Best and Brightest Talent	2016 - 2020	Year 4 (2019-2020)	Year 7 (2022-2023)	Below/ Meeting/ Exceeding
Number of faculty recruited in the top 5% of peer group	23	16	30	Exceeding
% of GWF graduate students and PDFs holding major awards and recognitions (*see Appendix I*)	46%	25%	35%	Exceeding
Participation in skills-based short-courses, cross-institutional training, and transdisciplinary boot camp (*see Appendix C*)	159	250	500	Below
Training opportunities, including leadership workshops, and special seminars (*see Appendix C*)	249	250	500	Meeting
Number of short-courses for early career researchers (*see Appendix C*)	76	12	20	Exceeding
Assignment of GWF mentors to early-career researchers (PDFs, research scientists and faculty <10y post PhD)	100%	100%	100%	Meeting

Figure 5.3: Attracting and Retaining Best of the Talent

c) Ability to Mobilize Knowledge for the Benefit of Society and the Economy

By the mid-point, over **478 unique partners/collaborators/knowledge users organizations** and individuals have been formally linked to GWF and engaged in the research process (*Figure 5.4* and *Tables 7-9*). These organizations provided **606 letters of support** for the 45 projects and core teams (*see Part 6 Letters of Support*). Some organisations sent multiple letters of support detailing distinctive areas of collaboration. These letters were provided by 69 Canadian Academic Institutions, 80 Academic and Research Institutions Aboard, 75 Private Sector Canada, 2 Private Sector Abroad, 105 Not-for-Profit Canada, 6 Not-for-Profit Abroad, 76 Indigenous Communities and Governments, 191 Public Sector Canada, and 2 Public Sector Abroad. Using CFREF and user-provided funds, **GWF has created and filled 965 jobs**, including 16 new faculty positions and 949 HQP posts. To support engagement with users and to provide solutions to their water problems, GWF has developed 40 promotional videos and 22 user tools. The videos, ranging from educational short documentaries to graduate student experiences, have received over **69,694 YouTube views**. A further **616 public outreach and community engagement events** were developed, expanding GWF community and sectoral engagement beyond those formally linked to GWF (*Figure 5.4*).

GWF strongly believes in science and evidence informing policy. A significant policy-impacting activity was developing the Water Security for Canadians Initiative to inform the development of a modern national water strategy and related institutional and legal frameworks for water. GWF has proposed that the 50 year old *Canada Water Act* should be updated to support implementation of Indigenous inherent, Aboriginal, and treaty water rights and roles in water governance and management; and, catalyze increased funding and capacity for freshwater monitoring, prediction, planning, and effective management. GWF further proposed that federal freshwater activities be centred, funded and coordinated in a **new *Canada Water Agency***. The recommendation for a Canada Water Agency was taken up in the **2019 Ministerial Mandate Letters** to the Ministers of Environment and Agriculture from the Prime Minister. Activities and consultations continue beyond the mid-point of GWF including a National Water Policy Panel - How can a Canada Water Agency Deliver Water Security for Canadians? and a promise to establish the **Canada Water Agency in the recent Speech from the Throne**.

Ability to Mobilize Knowledge for the Benefit of Society and the Economy	**2016 - 2020**	**Year 4 (2019-2020)**	**Year 7 (2022-2023)**	**Below/ Meeting/ Exceeding**
Number of end users and partners linked to the program and engaged in the research process (*see Tables 7-9 for details*)	478	300	500	Exceeding
Number of policy briefs and meetings with governments (*see Appendix L*)	194	20	50	Exceeding
Number of jobs created (HQP & new faculty)	965	450	850	Exceeding
Access of user tools (*see Appendix M*)	22	20	50	Exceeding
Hits to YouTube videos (*see Appendix N*)	69,694	10,000	100,000	Exceeding
Number of communities engaged in citizen science and public outreach activities (*see Appendix O*)	616	100	500	Exceeding

Figure 5.4: Ability to mobilize knowledge for the benefit of society and the economy

Water Day on the Hill was held in Ottawa on March 10, 2020 in partnership with Canada's Chief Science Advisor in order to provide direct scientific advice to decision makers. GWF and allied scientists and researchers from across Canada met with parliamentarians and senior federal officials to raise awareness

about issues around water security for Canada, and share information on how GWF's scientific knowledge can inform decision-making. This included testimony to the House of Commons Standing Committee on Environment and Sustainable Development.

In collaboration with the United Nations University, GWF launched a major report "Water Futures for the World We Want: Opportunities for Research, Practice and Leadership in Achieving Sustainable Development Goal 6" in November 2019 and presented the report to senior officials from the Sustainable Development Office of Employment and Social Development Canada, Statistics Canada and Environment and Climate Change Canada (ECCC) on a visit to Ottawa. The report uses GWF research to outline the steps by which Canada can achieve water sustainability through opportunities for research practice and leadership in support of the UN Sustainable Development Goal for water and santiation and related water and climate goals. It is a contribution to the UN Water Action Decade of 2019-2028 and has received very positive feedback from national and provincial governments and the user community.

On February 20-21, 2019, GWF co-hosted, with ECCC and NSERC's Floodnet Network, the first National Flood Forecasting meeting to begin dialogue between provincial and federal flood forecasting professionals in Canada, and to demonstrate the capability of Global Water Futures and ECCC streamflow forecasting systems, whilst highlighting new and important research in the area of streamflow and hydrological forecasting. The meeting has led to national discussions in Montreal (March, 2020) on development of a national water forecasting capacity and to improvements in provincial/territorial streamflow and flood forecast systems with the assistance of GWF (Alberta, Yukon, Saskatchewan).

GWF and Natural Resources Canada co-hosted a meeting in Ottawa of federal and GWF water scientists in November 2018 in order to strengthen program linkages, explore opportunities for joint research and coordination of water research. GWF and NRCan signed a MOU detailing further collaboration in the water geosciences that has strengthened federal engagement with many GWF projects and enhanced groundwater, forest hydrology, earth observation, climate change adaptation and glaciology research.

GWF's strategic communications and marketing plan forms the cornerstone of GWF outreach and engagement (*communications strategic plan*). Implementation of this substantial plan has resulted in a high profile for GWF that supports collaborations and partnership building, recruitment of students and other research personnel, and communication of early findings and impacts (see *Appendix P* for *Communication Activities and Highlights*). Plan implementation supports GWF goals through the following:

- Positioning Canada as a global leader in water science for the world's cold regions (where snow, ice, and frozen soils control the storage and release of water), a global partner of choice for transdisciplinary water research, and a provider for Canada and the world of strategic tools to manage water futures;
    - Developing strategies to increase national and international profiles aimed at key government influencers.
- Building national and international profiles for GWF and key partner universities by leveraging the communications, marketing, media relations, and social media strengths of partners and stakeholders;
- Enhancing and protecting the profile and reputation of GWF and its four institutional partners
- Supporting recruitment of HQP, international scientists as visiting fellows, research collaborators, and speakers;
- Celebrating and demonstrating the economic, environmental, and societal impact of funder investments; and,

- Developing research collaborations, donor relations, community initiatives, etc. in support of GWF objectives.

To implement this plan, GWF instituted a monthly eNewsletter in August 2017 to promote research outcomes and knowledge mobilization within the network and to engage with partners, collaborators, and end-users. GWF has also invested heavily in various social media platforms such as Twitter, Instagram and LinkedIn for public engagement and awareness. Moving beyond these standard approaches to stimulate awareness among different audiences, GWF has initiated an interdisciplinary "Artist-in-Residence" project to showcase and represent the impact of climate change and human actions on Canadian water resources. This science-art project has resulted in GWF-inspired art being exhibited in eastern and western Canada, UK and Belarus. This will be expanded to multiple artists and GWF projects in phase 2 as a virtual water gallery.

The communications team is crucial in the promotion, planning, and support of initiatives such as the Water Security for Canadians Initiative, in highlighting scientific research, researchers, and outcomes across all of our GWF projects through news releases, in developing science features, and editorial and advertorial content nationally and internationally, in advertising the annual science meetings [2018 Annual Meeting; 2019 Annual Meeting] and virtual events, meetings, and the recent GWF2020 iPoster session, in the participation of GWF in the Let's Talk About Water – Youth Engagement/Film Festival/International Film Prize; in managing and promoting the GWF annual speaker series such as the Distinguished Lecture Series, Women and Water Lecture Series, Knowledge Mobilization and Core Modelling webinar series; and in developing and maintaining the GWF website with a growing emphasis on scientific, data, and major policy outcomes (see *Appendix P* for *Communication Activities and Highlights*).