GLOBAL WATER FUTURES OBSERVATORIES

Supporting critical water research to safeguard Canadian water resources in an era of rapid change

2023–2029 Strategic Plan

INNOVATION
Canada Foundation for Innovation
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Contents

Above: Slocum autonomous glider for deployment in Lake Ontario to measure water quality parameters; part of the Real-Time Aquatic Ecosystem Observation Network (RAEON), led by the University of Windsor

Cover Photo: One of GWFO's meteorological stations at the Helen Creek Research Basin along the Icefields Parkway in Banff National Park, Alta.; part of the Canadian Rockies Hydrological Observatory, University of Saskatchewan

About GWFO and the Strategic Plan

Global Water Futures Observatories (GWFO)

GWFO is Canada's premier national freshwater research facility, funded in part through the Canada Foundation for Innovation (CFI) and its Major Science Initiatives (MSI) from 2023–2029. GWFO supports critical water research to safeguard Canadian water resources in an era of rapid change. It operates 64 instrumented water observation sites in lakes, rivers, wetlands, glaciers, and drainage basins across Canada; 15 deployable measurement systems for specialized field data acquisition; and 18 state-of-the-art water laboratories at the partner universities for detailed water quality, biological, and other analyses. The geographical scope of GWFO covers four major transboundary (interprovincial and territorial, international) river basins, including the Yukon, Mackenzie, Saskatchewan–Nelson, and Great Lakes–St. Lawrence. GWFO is led by the University of Saskatchewan (USask) and is a partnership amongst USask, the University of Waterloo, McMaster University, Wilfrid Laurier University, the University of Windsor, Trent University, Carleton University, the University of Western Ontario, and the University of Toronto.

GWFO provides open access to its freshwater data. It provides this urgently needed data to support flood, drought, and water quality solutions that help safeguard Canadian water resources. GWFO partners with Indigenous communities and practitioners and policy-makers in government, industry, conservation, and other sectors to develop capabilities, reduce risk, and better manage water as we face unprecedented challenges from global warming and rapid environmental change.

History

GWFO sustains a legacy of freshwater observations and scientific infrastructure investment in Canada that goes back many decades. A number of the sites are long-term water observatories that have records going back 50+ years, making them invaluable for the monitoring and detection of hydrological and water quality changes, and for developing in-depth understanding of the physical and biological responses to climate change and human pressures. Other sites have been established more recently, but contribute important and targeted observations in strategic and poorly monitored or poorly understood regions. Many GWFO observing sites were developed in cooperation with local Indigenous communities and have strong engagement with those communities.

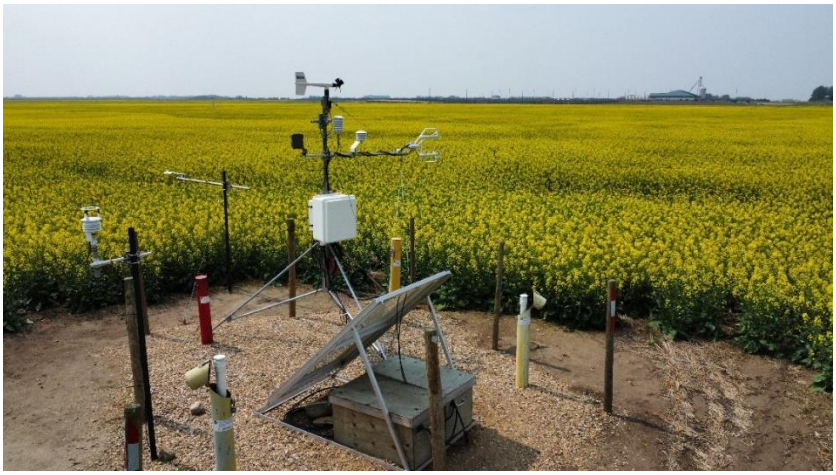
GWFO was realised through the investment in freshwater observing instrumentation and laboratories by the Canada Foundation for Innovation (CFI), the Natural Sciences and Engineering Research Council (NSERC), and federal and provincial/territorial government investments. Investment from CFI through its Major Science Initiative (MSI) has established GWFO as a national research facility with integrated management of Canada-wide field observations, operations and analysis, data management, and outreach and knowledge mobilisation with data users.

GWFO's Strategic Plan, 2023–2029

This strategic plan outlines the vision and mission of GWFO and the approach to realize this vision. The plan describes what GWFO aims to achieve and its priority research support directions along with the strategies that will be employed to deliver our overarching objectives. It is thus a

framework to establish a set of specific short-term plans and broader long-term plans, to guide our activities and set a pathway to functioning optimally as a national freshwater research facility.

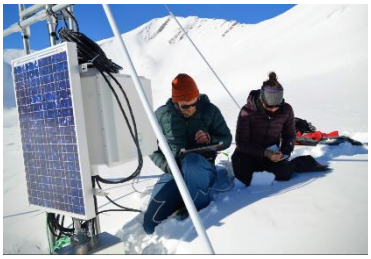
The strategic plan was approved by GWFO's Governance Board after development by GWFO's leadership, governance and management team, with guidance and direction from our User Advisory Panel (UAP) that represents a diverse range of users. It has been informed through formal consultations with users, where we have actively sought user needs and priorities, advice on our approach and on the use and access of our facilities and data, and suggestions for further developing the facility and its components across Canada. Through this, we are able to define the national scope and unified research support mission that makes GWFO unique and greater than the sum of its parts.

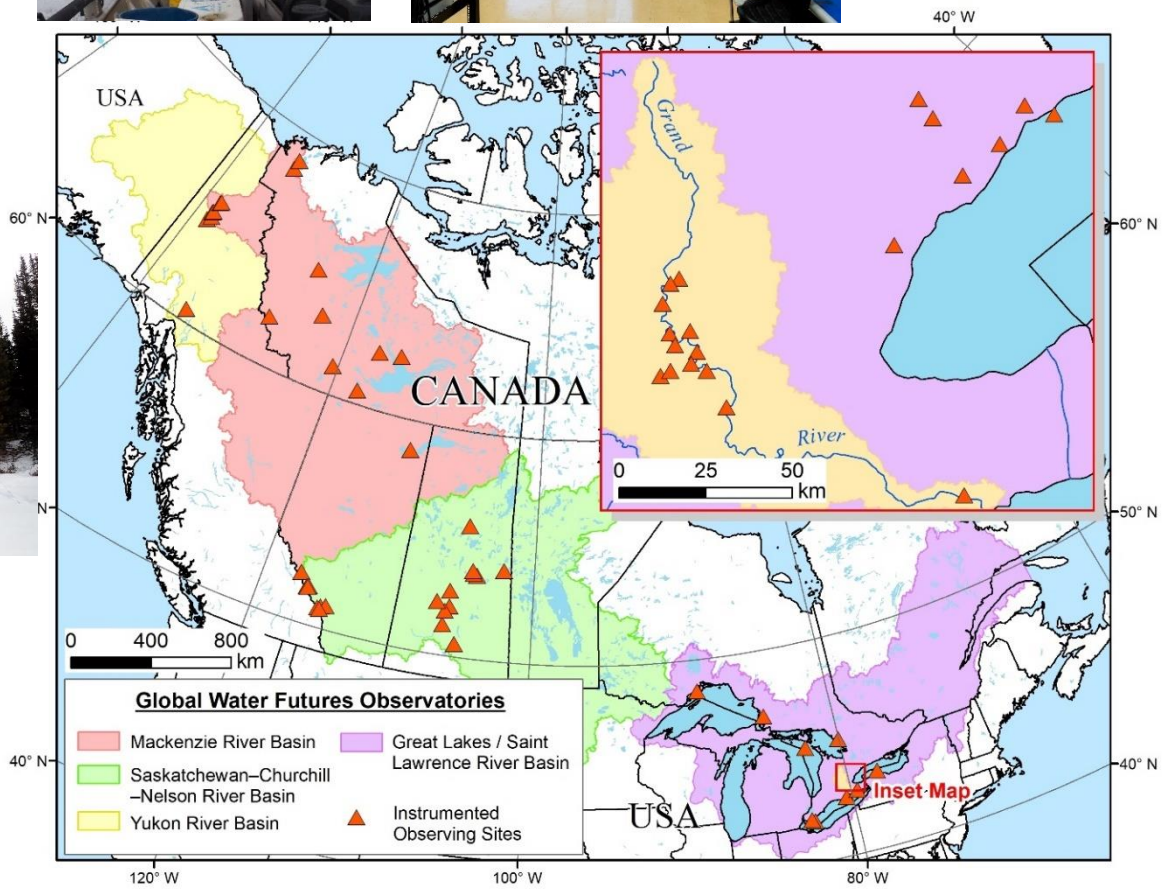


Meteorological station in a Canola field at the Kenaston / Brightwater Creek basin, SK, operated by the University of Saskatchewan

QIAcube Connect – RNA/DNA Extraction Instruments – at the Ecotoxicology Lab, University of Waterloo

GWFO – Canada's premier national freshwater research facility





GLOBAL WATER FUTURES OBSERVATORIES

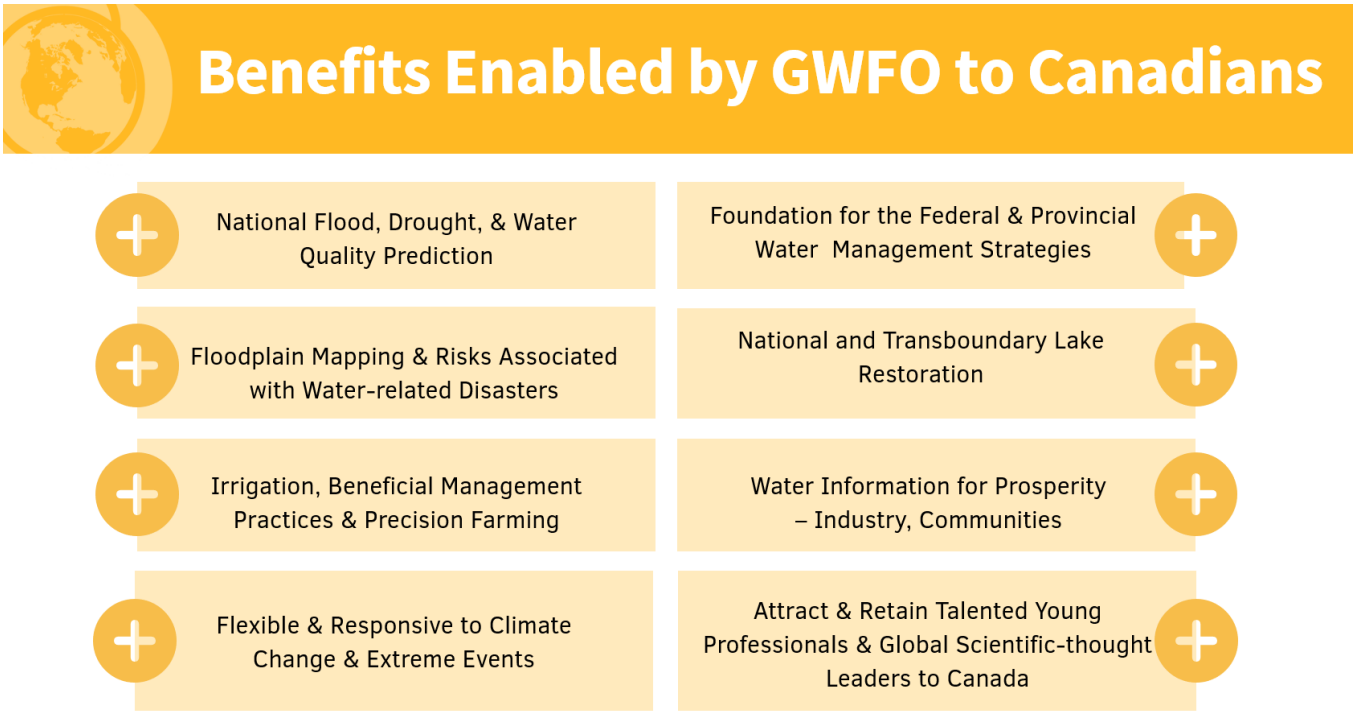
Vision and Principles of Operation

Our Vision

To operate a national freshwater research facility that supports critical water research to safeguard Canadian water resources in an era of rapid change. GWFO consists of instrumented water observing sites, supported by deployable observing systems and major laboratories, which provides open access water data and the necessary infrastructure to collect supplementary data. This data informs the development and testing of water prediction models, monitors changes in water sources, underpins diagnosis of risks to water security and helps design solutions to ensure the long-term sustainability of Canadian water resources.

Principles of Operation

- provide unique water data (beyond what provincial, territorial, and federal governments routinely collect) of interest to characterizing and monitoring the water conditions of Canadian river basins
- contribute to a critical baseline of water data to the benefit of multiple users
- support the data collection from, and analysis of water from a pan-Canadian network of instrumented water observing sites
- adhere to the principles of open access



Current State of GWFO

GWFO is now well established as Canada's premier national freshwater research facility. GWFO technicians collect a vast array of observational and experimental freshwater research data which is managed by our Data Management Team and output to users who also directly access the facility to conduct novel and innovative research underpinned by GWFO's capabilities. We actively engage in outreach, communication, and knowledge mobilisation to share important and timely discoveries made using the facility.

Launch

On 29 February 2024, the award agreement for GWFO (MSI 42687) was fully executed by CFI-MSI (retroactively for a formal commencement of GWFO on 1 April 2023). In the Spring of 2024, the website was developed (www.gwfo.ca), GWFO held an open, national, hybrid event (in person and online) to mark the formal launch of the facility (https://gwfo.ca/news-events/events.php), and began an extensive effort to engage partners and users and collaborate with other organisations.

Establishment of the GWFO User Advisory Panel

GWFO established a User Advisory Panel (UAP) comprised of representatives from Indigenous communities, federal/provincial/territorial/municipal governments, water management bodies, industry, and practitioner and data user groups. The UAP is intended to build user engagement with GWFO, provide insights into the user science and decision support needs underpinned by the GWFO data, provide recommendations and avenues for translating GWFO's data to support the real-world impacts, and enhance scientific exchange with private and public sectors and Indigenous organisations and communities. The panel provides strategic advice in identifying and catalysing new opportunities to grow GWFO's user-base and services. There are now 39 members of the UAP, many of whom are new users. The member listing and terms of reference can be found at https://gwfo.ca/about/management-and-advisory-committees.php under the User Advisory Panel tab.

Eddy covariance instrumentation on top of flux tower at the Turkey Point Environmental Observatory, ON, operated by McMaster University

Establishment of the GWFO Governance Board

GWFO has established a Governance Board that ensures the vision, mission, and objectives of GWFO are achieved, monitors activities and progress, holds the facility to the highest standards of operational excellence, promotes broad engagement with national and international partners and key stakeholders, ensures that finances are well-managed, that the facility is optimized for supporting research and training, and that the facility fully adheres to CFI, university, other major funding partners' policies and procedures. The membership of the Board has been filled and Terms of Reference have been adopted. More information can be found at https://gwfo.ca/about/management-and-advisory-committees.php.

GWFO Data Management System

GWFO's instrumented sites, deployable systems, and laboratories provide critical freshwater data for a vast range of users. Significant effort has gone into developing the data management system, facilitation of data access, and the GWFO Data Policy, https://gwfo.ca/data/data-policy.php. At its core, the Data Policy requires the open access and provision of all GWFO *Operational Data* (routine data collection) as part of the normal functioning of the instrumented site or deployable system, including, but not limited to hydrometeorological, cryospheric, water quality/quantity, ecological/biological, toxicological, and other water-related variables.

A sophisticated data management and access system has been established for GWFO using the https://gwfnet.net/ software. GWFNet is a data catalogue and information management system for GWFO and related information. It serves as a centralized cataloguing system to allow access to data, metadata, publications, and other important information related to water science from GWFO facilities.

Operations and Coordination

An *Operations Team* has been formed for GWFO, consisting of facility leads, managers, technicians, data management staff, the Secretariat and the Strategic Management Committee (SMC). This team is to enhance interactions among all facilities and teams, identify gaps, opportunities, and best practices, track progress, and enhance communication, knowledge mobilisation, and data sharing. A virtual workshop on observations and data (https://gwfo.ca/news-events/events.php) was held in October 2024 to bring this team together to better understand GWFO's observation and data systems, what data GWFO is collecting, what QA/QC systems are in place, and to explore data management and storage issues at the various GWFO partner institutions. See the **Workshop Report**, which provides concrete near-term strategies and actions to advance and improve GWFO.

Newly deployed SuperBuoy for water quality monitoring at Buffalo Pound Lake, SK; Saskatchewan Water Chemistry and Ecology Laboratory

Mission and Objectives

GWFO is a national freshwater research facility that provides essential data to help researchers and other users develop sustainable water resource management solutions. GWFO resources are deployed to generate, process, analyze, manage, and visualize exceptionally large quantities of data – "big data for water sustainability solutions"– to inform development of computer modelling and analytical tools for water-related disaster warning, to support prediction of future water flows and risks to water quality, and to provide the quantitative support for adaptation to climate change and associated risk management in users groups and communities across Canada. Data from GWFO's pan-Canadian observation sites and laboratories is managed together to inform and evaluate water models that are applied across Canada. The GWFNet web-based portal disseminates GWFO data to provincial, territorial, and federal government agencies, industry, agriculture, communities, and other researchers and is being further enhanced to support user needs. This leads to a sustainable business model for GWFO's big data, based on support from its large user base and strong support of solutions for user-defined questions that will help Canada achieve water sustainability.

Objective 1: Provide unique and high-quality water data and analytical capabilities to characterize Canadian freshwater conditions and support world-leading water science

To monitor and help support the development of solutions for the impending water crisis that is facing Canadians and to provide the observational and analytical data (beyond routine provincial, territorial, and federal government observations) that underpins transformative science and advances the understanding of hydrological and ecological systems and their interconnections.

Objective 2: Support water-related disaster warning and assessment of risks to water quality

To act as an early warning system for the water disasters that increasingly afflict Canada and to provide quantitative support for adaptation to climate change and associated risk management in user groups and communities across Canada.

Objective 3: Meet the needs of a diverse range of users, partners, and communities

To provide the data, services, and expertise for developing decision support systems, monitoring and planning, and help in the design of solutions to allow water users, stakeholders, and rightsholders to adapt to the changing climate and achieve water sustainability.

The Trent University Water Quality Centre (WQC) is a comprehensive mass spectrometry facility that generates baseline and time-sensitive data via measuring isotopes and trace amounts of organic and inorganic contaminants in biological material, sediments, soils, fly ash, municipal wastewaters, industrial by-products, process waters and other environmental compartments.

Strategies and Actions

To fulfill these objectives there are a number of important strategies and actions, including, but not limited to the following:

1. Ensure ongoing and regular maintenance of GWFO instrumented sites, deployable systems, and water laboratories so that data is collected seamlessly and without interruption

It is vital to ensure the continued maintenance, servicing, and upkeep of the GWFO instrumented sites, deployable systems, and water laboratories for reliable and uninterrupted operation. Facility leads, managers, and technicians must routinely oversee and maintain smooth operations of the facilities and ensure that equipment is functional and in good working order, problems are addressed in a timely manner, necessary maintenance and repairs are carried out and all data is collected. This also involves fast responses to instrument malfunctions or failures, and rapid mitigation of any observational downtime.

***Actions*: •**Regularly visit field sites and maintain laboratories, and provide logistical support for technicians to effectively carry out their duties. •Seek further support and funding to ensure the long-term sustainability of GWFO facilities and infrastructure.

2. Develop a collective understanding of our field observatories and labs and what they do

Individual GWFO instruments originated through a wide range and variety of infrastructure investments. Their unique and high-quality observations and analytical capabilities are integrated by GWFO to meet its objectives. This integration adds great collective value, and to effectively realize this value, we must develop a collective understanding of the contributions of various

elements of GWFO towards its vision. GWFO is a vast pan-Canadian research facility supported by nine universities, with about 50 employees and dozens of faculty members working together to ensure that instruments are operating and data is flowing to users. It is important to continue to meet collectively, assess the state of GWFO, what we are doing, our future individual and collective priorities, and to explore possibilities for improving sites and harmonizing and making more interoperable the diverse research facilities that GWFO supports.

***Actions*:** •Meet regularly as a network and as sub-groups, committees, and teams (e.g., Operations Team, Technical and Data Management Teams, SMC, UAP). •Facilitate and maintain internal lines of communication, updates, and interactions. •Visit other sites and labs, carry out short personnel exchanges to work at other facilities.

3. Coordinate activities and operations internally and strategize towards our common mission

Working together to collectively understand our individual facilities is important, but this must also be taken further with internal network coordination to function coherently with unified purpose and activities toward our common objectives. We must work cooperatively and collaboratively. This can be done through the development and sharing of best practices, expertise, knowledge, and skills, common approaches and coordinated activities across multiple facilities, and approaches to respond to extreme events (e.g., droughts, floods, water quality episodes, etc.).

***Actions*:** •Building on actions under Strategy 2 above, develop sub-groups of the technicians and site leads to examine issues of compatibility, optimal approaches, and interoperability. •Conduct cross comparisons of specific measurement approaches within thematic groups such as hydrometeorology, lake ecosystems, flux towers, cryosphere, groundwater, wetlands, forests, agriculture, urban areas, chemistry, and eDNA. •Explore further opportunities for common activities.

4. Engage with users to understand their needs

GWFO has a strategic advantage in its large user-base of almost 30,000 users. GWFO needs to continue developing and strengthening existing relationships and to discover new users. This should support better understanding of changing data needs. GWFO's service model uses strategic knowledge mobilisation (KM) to ensure that GWFO data and the facility are put to fullest use in supporting Canadian freshwater data users. (See the **KM Strategic Plan**, which outlines an action plan to support these activities.)

***Actions*:** •Maintain active engagement with the user community as a whole and through individual points of contacts. •Fully utilize the UAP and draw on their collective and individual expertise for guidance, insights, and strategies. •Explore opportunities to frame GWFO data in Indigenous knowledge streams in discussions with Indigenous communities. •Foster active partnerships with ECCC's National Hydrological Service and the Canada Water Agency, and develop synergies in data management. •Develop an inventory of existing data users that makes their needs clear, in the form of a database that allows for ongoing updating and analysis. •Implement user satisfaction and feedback forms to collect actionable information to improve GWFO operations.

Meteorological station and flux tower above the Arctic Circle in the shrub tundra at Trail Valley Creek Research Basin, NWT, operated and maintained by Wilfrid Laurier University.

5. Develop and maintain a centralised, responsive and efficient data and analytical service discovery and delivery system

This is a core function of GWFO and central to its mission—provision of high-quality, unique, timely, and accessible data and analytical services that underpin our users' research and monitoring initiatives. This involves ensuring that the observations, data, and services are fit-for-purpose and useable, that the data streams are feeding into the science and monitoring through proper channels, that relevant data is findable and accessible, and that it is properly archived in reliable long-term repositories. It is key to understand and evaluate data collection, quality assurance and control (QA/QC), and management processes to optimize workflows, including their interface with management of GWFO's freshwater research infrastructure. (See the **Data Management Strategic Plan**, which outlines an action plan to support these activities.) The strategies and actions build on the above (points 1–4) on maintaining, collectively understanding, and coordinating GWFO facilities, and consulting with existing and potential users to explore requirements for data types and service characteristics.

***Actions*:** •Design and implement a central web-based portal that is easy to navigate, links seamlessly with other web-based GWFO resources, is secure and reliable, responsive, fast, informative with relevant material, and accessible and inclusive. Several stages of user testing should optimize navigation, discovery, and administrative features. •Implement a central helpdesk service that complements the web portal by delivering professional advice while at the same time collecting valuable information about user requirements and opportunities for outreach.

Aquatic surveying (backpack electrofishing) along the central Grand River in southern Ont. University of Waterloo.

6. Build capacity in data discovery, management, visualisation, and use

Tools and methods for scientific data collection, management, and formatting are changing rapidly. To further enhance the provision of data and services, GWFO needs to reflect this and build knowledge renewal—for both operational team members and users—into its ongoing operations to become a learning-focused organisation. GWFO needs to constantly scan the environment for systems that could improve operations and continue consulting with existing and potential users to explore and understand requirements for data types and service characteristics. There is increasing demand for combination and visualisation of datasets and development of interoperability tools to create new data products and increase the capacity of users to deploy these data.

Actions: •Develop and offer training opportunities, in partnership with data users, to build capacity in the use of GWFO data, data management methods and their application. •Continue to evaluate GWFO operations and respond to user satisfaction responses to improve operations (see also **Measuring Success** below). •Develop and maintain an inventory of data repositories and data resources that support GWFO and its users.

7. Communicate GWFO data, outcomes, and insights on Canadian water conditions and extreme events, and science advances supported by GWFO

Communication and outreach to our users and the public are key elements of the GWFO strategic plan. Canada and the world face increasing risks from climate and environmental change, geopolitical instability, human activities, and threats to aquatic systems, and GWFO provides exemplary observations, data, and analytical services to help develop solutions to the water crisis

and managing risks. It is therefore imperative that we share our observations, insights, and findings, our expertise on key issues, and scientific advances supported by the GWFO facility. (See the **Outreach Strategic Plan**, which outlines an action plan to support these activities.)

***Actions*:** •Engage the media and share insights and perspectives from GWFO on Canadian water conditions, extreme events, science advances, etc. •Circulate a newsletter amongst the GWFO's users to keep them informed of activities, events, and new developments. •Share stories and experiences on our website, communications, social media, and other channels to promote the facility, resulting research, and particular topics or issues of interest.

8. Expand the user base, expand the facility through collaboration, and ensure long-term sustainability of GWFO as a national research facility

A key element of the national value of GWFO is the long-term nature of many of the observatories, the cumulative understanding of natural and disturbed systems that this provides, and the how this has supported research advances such as diagnosing and predicting freshwater change. Maintaining the facility far into the future is imperative, and this should be done concomitantly with expansion of the user base and linking complementary research sites and infrastructure into the facility on a no-cost basis through collaborations. GWFO must attract and secure funding for the facility, ensure that its data supports new scientific advances, whilst also ensuring the national coverage of the facility across Canada. This strategy relies on all the above initiatives, creating greater awareness of the value of GWFO.

Equipment including a SeqStudio Fragment Analyzer, Tecan Spark Plate Reader, and ProFlex thermal cycler at the Environmental Genomics Facility, University of Windsor.

***Actions*: •**Identify and categorize existing and potential users through inventory of existing users and outreach to new ones, and by continuously reviewing user needs, for ongoing enhancement of the GWFO's user base. •Expand the network to cover more of Canada—this involves formal collaboration with universities that have instrumented, long-term research sites on a no-cost basis to GWFO. •Seek out long-term funding and support to sustain GWFO.

Measuring Success

There are several ways in which we can quantitatively and qualitatively measure our success and determine that we are meeting our objectives, as described below.

GWFO Key Performance Indicators

We have baseline key performance indicators (KPIs) and targets for 2029 used for our annual reporting to CFI. Meeting these is a good quantitative indicator of GWFO success. These include number of users (by type, location, and sector), demand and requests accommodated, optimal use of facilities, staff, user satisfaction, outputs (presentations and publications), outreach (events, media, symposia), training, technology transfer, partnerships, international leadership, and external funding. Reporting on these is a major part of our annual reporting and an important measure of our productivity and performance.

Key Performance Indicator	2029 Target	Notes
Users	3495	Number that access facilities or use data
Fulfilled demand	100%	Requests for access that are fulfilled
Optimal use	75%	Tracks the facility use compared to optimum
Satisfaction	4/5	From user survey and satisfaction ratings
Research outputs	765	Publications and presentations
Outreach	524	Engagement activities with users and public
Training	442	Number of highly qualified personnel trained
Technology transfer	2	Patents, licenses, spin-offs, and transfers
Partnerships	398	Partnerships with outside groups
International leadership	179	Programs, committees our members serve
External funding	$10.28M	External funding brought in and leveraged

Documentation and evidence of use

We need stories and a supporting narrative around our KPIs to show not only the numbers, but a description of how GWFO data, services, and outputs are important for our users and partners. For example, we are actively gathering information from all of our facilities, asking, for example, who are some of the key users, how many people in their organisation use of data/services, how does the facility support their needs, what do they use the data and/or analytical services for, etc.?

User engagement and satisfaction

Continual engagement with our users and partners provides a means to assess and evaluate our success in meeting GWFO objectives and the user needs. This is an activity that forms part of our Outreach, KM, and Data Management strategies, and is crucial for gathering feedback and being

responsive to user needs. In addition, we have implemented a user satisfaction form that asks questions such as How satisfied were you with the responsiveness of the GWFO team? How would you rate the ease of accessing the requested data, site, laboratories, or equipment? How satisfied were you with the quality of the data, laboratories, or equipment provided? Were the resources provided helpful in achieving your objectives (please explain/elaborate below)? How satisfied were you with the support and guidance from the GWFO staff? Would you recommend GWFO resources to others? Additional Comments - Please provide us with any other feedback or suggestions. This not only provides a quantitative measure for many aspects of meeting user needs, but provides an opportunity to gather feedback, respond in our approach, and learn and grow as a network.

Meteorological station in the permafrost-underlain Tombstone Waters Observatory along the Dempster Highway, Yukon. Operated by McMaster University.

What does success look like?

GWFO has three main objectives: 1) providing unique and high-quality freshwater data and analytical services (beyond what provincial, territorial, and federal government networks routinely collect), 2) providing data support for disaster warning and risk assessment, and 3) meeting the data and science support needs of a diverse set of users. Success in achieving these will be indicated, not by meeting any single milestone or deliverable, or accomplishing a certain activity by a set date, but by ongoing and continual work over our initial period (2023–2029) and beyond with renewal, steadily increasing recognition and reliance on GWFO data and services, and the provision of these towards addressing Canada's water challenges and supporting user needs. In addition to the quantitative indicators above, there are a number of qualitative indicators that can help define what success looks like for GWFO:

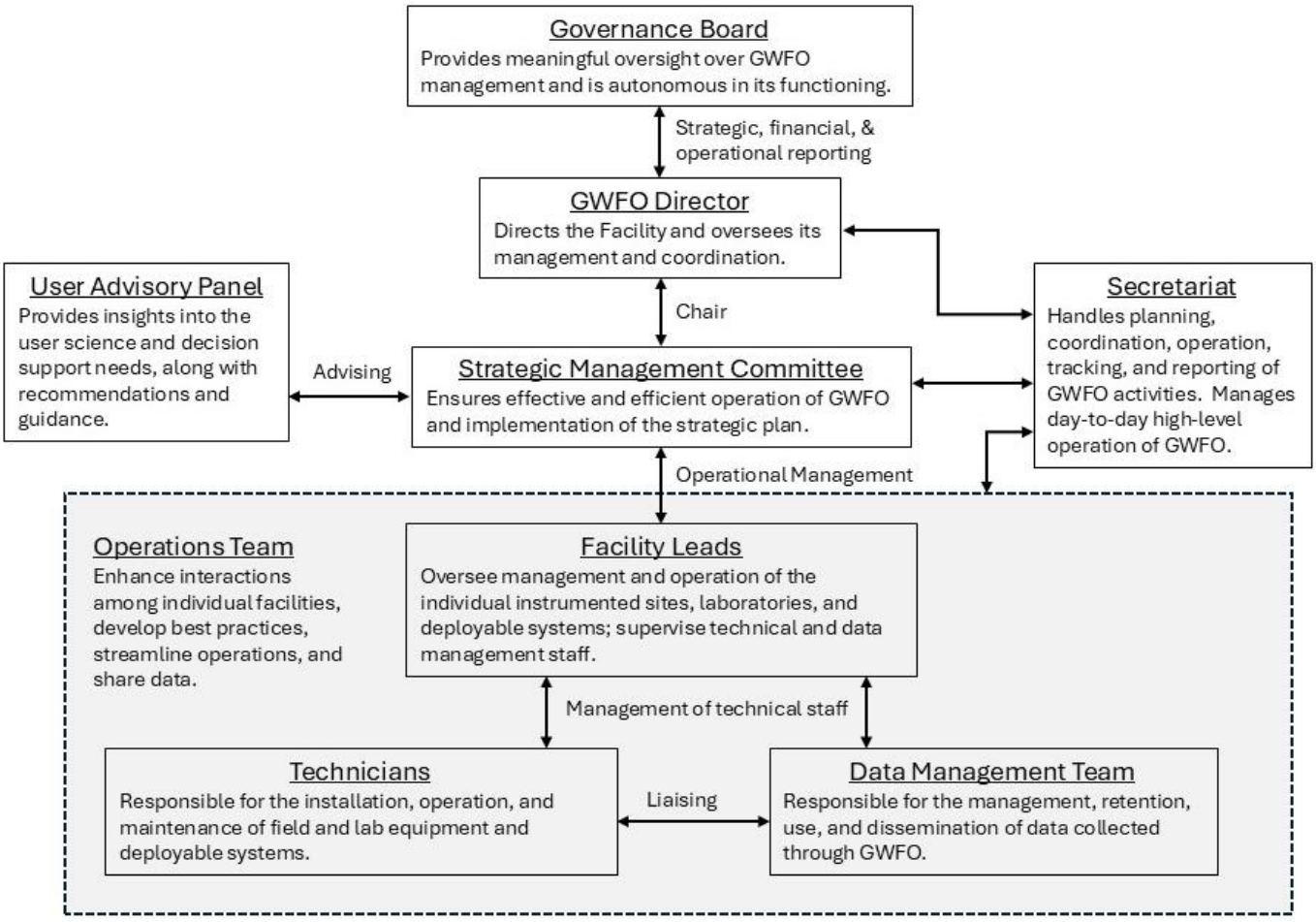
- GWFO instrumented sites, deployable systems, and water laboratories continue to operate at or near optimal use levels, measuring and analyzing the full suite of variables as established at GWFO's inception. Expansion to more sensors, stations, research basins,

deployable systems, and laboratories and lab equipment—if new funding and support can be obtained—would be an even greater indication of success.

- Data and analytical services are provided freely (where governed by our data policy) or on a fee-for-service basis to users and partners, and demand and requests are fully met (at least where possible feasible to do so). A wide range of data types and analytical services are used in support of multiple applications. Our user base grows and GWFO supports an increasingly large and diverse community of users.
- Science and evidence-based decision makers recognize GWFO as a reliable, knowledgeable, and supportive partner. GWFO data are used directly to inform management, policy, and decision making. This includes local to regional, provincial and territorial, national, and even international science-to-policy translation and uptake, informed by GWFO data. Use of GWFO observations and insights help guide new agreements and treaties or are used towards negotiations among different stakeholders and jurisdictions.
- GWFO advanced warning and near-real time data provide essential observations and insights to help prepare for and manage impending water disasters or emergency situations. Operations and management decisions are modified in response to help mitigate risks and damages.
- Canada continues to be seen as a leader in cold regions water science, freshwater observation and analytical approaches. GWFO continues to work with various international agencies and organisations, boosting Canada's reputation in this area, and being recognized internationally as a partner and collaborator of choice.

Governance and Management

GWFO's operations and activities are managed and overseen using a tiered approach of three decision-making levels: governance, strategic management and operational management, supported by the Secretariat and guided by the User Advisory Panel (see below and https://gwfo.ca/about/management-and-advisory-committees.php and https://gwfo.ca/about/staff-and-personnel.php).



Governance and oversight of GWFO is overseen by a **Governance Board** (herein referred to as the Board). The Board is composed of representatives of prominent data user organisations, prominent experts on freshwater data collection and management, and the Vice-Presidents Research of USask and a rotating member from among the other partner institutions. The Board ensures that the vision, mission, and objectives of GWFO are achieved, monitors activities and progress, holds the facility to the highest standards of operational excellence, promotes broad engagement across the partner universities as well as other national and international partners and key stakeholders, ensures that finances are well-managed, that the facility is optimized for supporting research and training, and that the facility fully adheres to CFI, university, other major funding partners' policies and procedures.

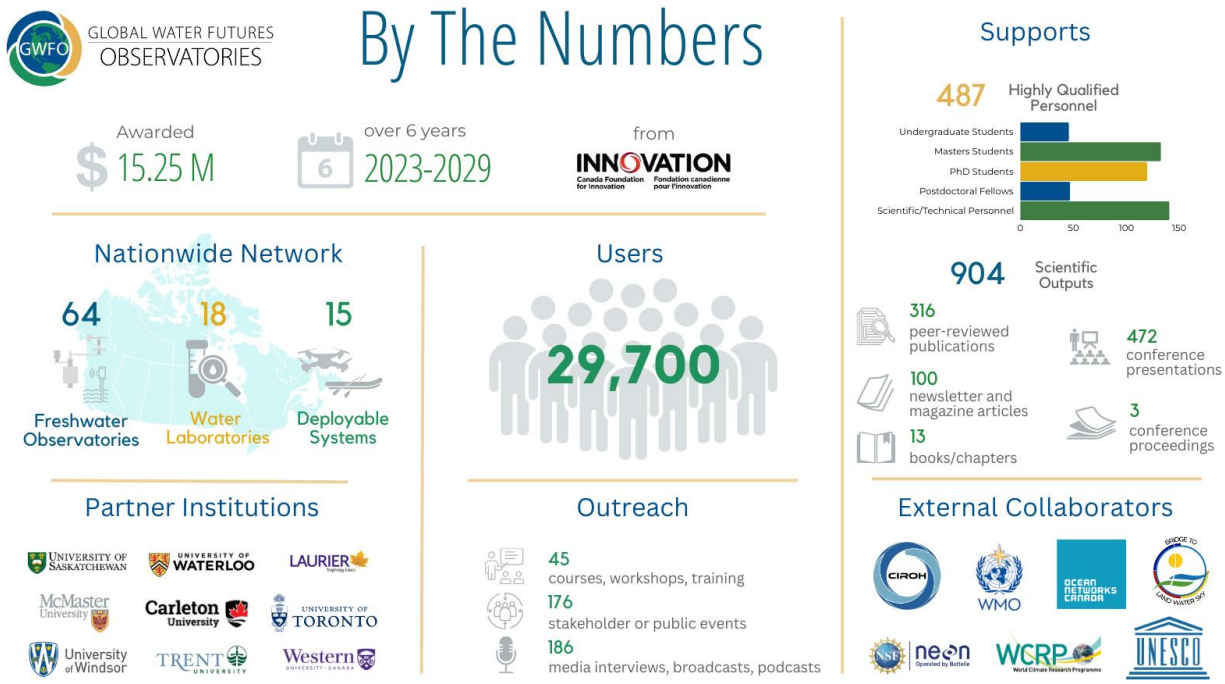
Management and strategic initiatives of the facility are implemented by a **Strategic Management Committee (SMC)** that reports to the Board. The SMC is Chaired by the **GWFO Director** and includes representatives from each of the main partner institutions as well as other expert scientific expertise representatives. It is the primary management and executive committee for GWFO, responsible for providing direction and ensuring optimal operations and utility towards supporting monitoring and transformational science, managing GWFO finances and budget, and providing recommendations to the Board for allocating resources. The SMC is supported by the Secretariat and the User Advisory Panel (UAP).

The GWFO **Secretariat**, based at the University of Saskatchewan, is responsible for the planning and coordination of network activities, ensuring the continued operation and proper functioning of the facility, tracking and reporting usage metrics, and liaison with management, oversight, and advisory committees in the execution of these tasks.

The **User Advisory Panel (UAP)** is comprised of a wide range of representatives of GWFO data and service users and people in a position to provide solid guidance and advice. The UAP is intended to build user engagement with GWFO, provide insights into the user science and decision support needs underpinned by the GWFO data, provide recommendations and avenues for translating GWFO's data to support the real-world impacts, and enhance scientific exchange with private and public sectors and Indigenous organisations and communities. The panel provides strategic advice in identifying and catalysing new opportunities to grow GWFO's user-base and services.

The GWFO **Facility Leads** oversee and direct operations and data collection at the instrumented sites, laboratories, and deployable systems, or work directly with others responsible for the sites to support operations and act as GWFO liaisons. The leads are professors and faculty from our partner institutions who supervise technical and data management staff. The GWFO **Data Management Team** includes staff at each of the major partner institutions with oversight and direction from experienced faculty representatives at these universities, as well as high-level guidance from the SMC. This team is responsible for the management, retention, use, and dissemination of data collected through GWFO. GWFO **Technicians** are responsible for the installation, operation, and maintenance of field equipment and deployable systems, and for gathering data from these systems and liaising with data managers to ensure preservation and accessibility of data. Technicians assist and/or manage GWFO laboratories and oversee sample analyses and maintenance of lab equipment. Together, this group comprises the **Operations Team**, which facilitates coordination and sharing of best practices, identification of gaps and opportunities, tracking of progress and facility usage metrics, and enhances communication, knowledge mobilisation, and data sharing.

GWFO By-The-Numbers



Key numbers from the GWFO facility as of December 2024

Panoramic view of the TRACES Centre, a state-of-the-art aquatic chemistry analytical lab, operated by the University of Toronto, Scarborough.

Appendix A: GWFO Knowledge Mobilisation Strategic Plan

From Collecting Data to Provision of Water Information Services: Knowledge Mobilisation Strategy for Global Water Futures Observatories Concept Note and Proposed Action Plan

Background

The Global Water Futures Observatories (GWFO) is Canada's premier national freshwater research facility that emphasizes the collection of data about water availability and quality. Data from these sites informs predictive model development, detects changes in water supply and quality, and advances water science. GWFO provides an early warning system for the water disasters that increasingly confront Canada, and services that support mitigation and adaptation through improving the availability of, and access to, reliable data, monitoring and predictions.

GWFO is funded in large part by the Canada Foundation for Innovation Major Science Initiatives (CFI MSI) Fund.

Collaborating institutions are:

- University of Saskatchewan
- Carleton University
- McMaster University
- University of Western Ontario
- Trent University
- University of Toronto
- University of Waterloo
- University of Windsor
- Wilfrid Laurier University.

Over the next six-years, GWFO will be deployed as a service to generate, process, analyze, manage, and visualize large quantities of data – 'big data for water sustainability solutions' - to inform development of computer modelling and analytical tools for water-related disaster warning, prediction of future water flows and risks to water quality, and to provide the quantitative support for adaptation to climate change and associated risk management in user groups and communities across Canada. The service will be based on data telemetry, storage, management and visualisation systems.

Guided by a User Advisory Panel, this service will be developed to disseminate collected data and synthesized outputs to provincial, territorial, and federal government agencies, industry, agriculture, communities, and other research institutions, and will be further enhanced to support changing user needs. All data collected by the network will be available free of charge to any user. Access to field observation sites, deployable systems, and major laboratories will be managed under a fee for service framework.

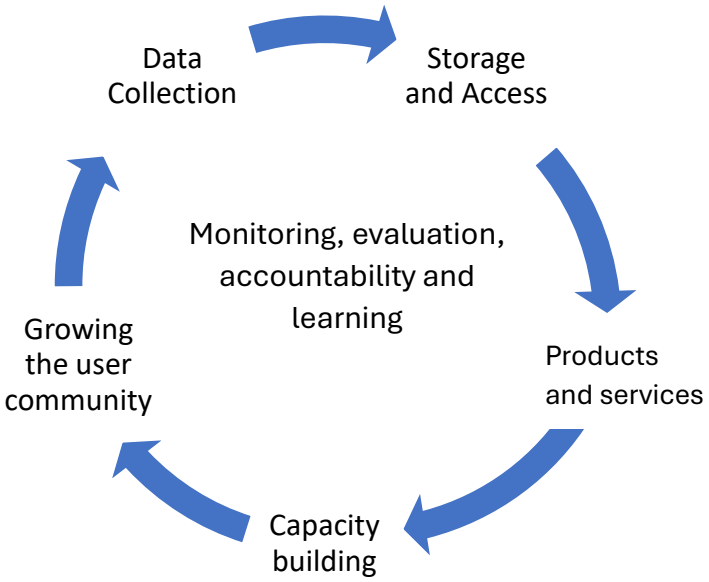
Vision for Knowledge Mobilisation

Key to implementation of the service model are knowledge mobilisation (KM) efforts to ensure that GWFO data and products are put to fullest use in supporting Canadian water security, and in predicting and mitigating water-related risks. This vision for GWFO sees transformation, through partnerships, of the existing GWF network into a nationally-recognised water information services organisation. This document outlines a proposed action plan for activities by the GWFO Secretariat that support this objective through a process on ongoing strategic learning that builds adaptive capacity among water researchers, practitioners, and decision-makers.

Expanding Strategic Use of Observatory Data through Development of Actionable Knowledge]

While primary users of GWFO facilities, data and data products are likely to be scientists and practitioners working on water resources, GWFO's ultimate objective will be to provide evidence to inform planning and decision-making. Looking at demand-driven processes for evidence, the Global Commission on Evidence to Address Societal Challenges points out the need to better influence demand by encouraging incorporation of evidence use into routine advisory and decision-making processes, by contributing to a culture of using evidence, and by strengthening capacity for evidence use. It also calls for coordination at the interface between evidence demand and supply through eliciting the needs of decision-makers and their advisors, aligning packaged evidence with these requirements and with decision-makers' preferred communication formats, while paying close attention to societal context. (Global Commission on Evidence to Support Societal Challenges 2023)

The following diagram represents the operational cycle of the GWFO service, with user engagement at each stage in a loop contributing to awareness, relevance, credibility, legitimacy, and understanding of useable evidence for water security:



The proposed action plan for GWFO KM is based on five key functions that support the use of data in both scientific and governance processes:

1. Development and maintenance of a **responsive and efficient data discovery and delivery service**
2. Building **capacity in data discovery, management, and use**
3. Continuous development of a **network of knowledge partners**
4. Environmental scanning and engagement to **ensure relevance** and enhance the GWFO **user base**
5. Constant **developmental evaluation** of GWFO operations to capture learning and improve operations.

A responsive and efficient data discovery and delivery service

Developing an effective, responsive information infrastructure service requires application of a sound business model with supporting systems. This includes understanding and evaluating data collection, QA/QC and management processes to optimize workflow, including their interface with management of GWFO's infrastructure and facilities.

Initial activities to support this should include:

- development of composite **user profiles** that reflect the mix of stakeholder interests
- consultations with existing and potential users to explore **requirements for data types and service** characteristics
- design of a **web-based portal** that is easy to navigate, links seamlessly with other web-based GWFO resources, is secure and reliable, responsive, fast, informative with relevant material, and accessible and inclusive – business sites that deliver services should be explored for examples of useful features. Several stages of user testing should optimize navigation, discovery, and administrative features.
- consideration of a **helpdesk service** that complements the web portal by delivering professional advice while at the same time collecting valuable information about user requirements and opportunities for outreach.

Building capacity in data discovery, management, visualisation, and use

Tools and methods for scientific data collection, management, and formatting are changing rapidly. GWFO needs to reflect this in its powering-up process and build knowledge renewal – for both operational team members and collaborator/partners -- into its ongoing operations to become a learning-focused organisation.

- The GWFO Secretariat will provide a service to external users. Staff members will become familiar with the business-like model of the service, and trained to constantly scan the environment for systems that could improve it. Other organisations will be called upon early in GWFO's gearing-up phase to share lessons learned about capacity needs.

- There will be increasing demand for combination and visualisation of datasets and development of interoperability tools to create new data products. Continuing professional development should be planned and budgeted as part of GWFO KM activities. Capacity building should extend beyond GWFO Secretariat to include GWFO partner and collaborators, and benefit from external training and secondment opportunities.
- Creating an inclusive and accessible service that adds innovation value through diversity of knowledge and experience requires attention to principles of Equity, Diversity and Inclusion (EDI). There will be an ongoing need for awareness creation and development of practical strategies to evaluate GWFO's social 'reach' and use of a broad cross-section of user knowledge and experience to strengthen the relevance and utility of its product.
- Planning for ongoing short training in the use of GWFO data, data management methods, modelling tools and their application, will be designed in partnership with data users

Continuous development of a network of collaborators and knowledge partners

GWFO has a strategic advantage in the existing network of collaborators and partners that has grown through a series of large, networked science projects, including Global Water Futures. It needs to continue developing this resource to strengthen existing relationships and to discover new user requirements in terms of both types of data and geographical location. This should support better understanding of differences in regional needs and culture. Collaboration could extend to co-location of site facilities with long-term data collection in other disciplinary areas. GWFO will consider boundary organisations such as climate services providers as key partners.

An immediate need is to develop an inventory of existing collaborators and partners that makes gaps and opportunities for expansion clear., in the form of a database that allows for ongoing updating and analysis. This would be facilitated by the consultations described in Section 1.

Environmental scanning and engagement to ensure relevance and enhance the GWFO user base

Getting GWFO data into use is a priority, making the fullest possible use of collected data and data products by engaging current and potential users of GWFO data to build awareness and assess new user requirements. This is an ongoing process that should improve with time and fine-tuning of GWFO operations.

Time and resources for collection and maintenance of information to support client relationship management should be built into GWFO operations with clear areas of responsibility and reporting identified.

As with development of a network of collaborators and partners, identifying and categorizing existing and potential users through inventory of existing network participants and outreach, and by continuously reviewing user needs, will lead to ongoing enhancement of the GFO's user base.

Constant developmental evaluation of GWFO operations to capture learning and improve operations

GWFO performance will be assessed based on the following Key Indicators. A process to track these indicators through project progress reporting has been proposed and agreed upon by CFI MSI Secretariat.

CFI MSI Key Indicators	GWFO KM Functions
Users – users of facilities and data	1,4
Demand – user demand for access to facility	1,4
Use – optimal use of the facility	1,4
Staff – technical and management staff	
Satisfaction – User satisfaction	1,4
Outputs – research outputs and knowledge translation	1,2
Outreach – outreach and public engagement	1,3,4
Training – training of highly qualified personnel	2
Tech Transfer – technology development and transfer	2,3
Partnerships – local, national and global partnerships	3
International Leadership – organisations and committees	3
External funding – leveraged funding	3

Workplan activities

First six months (identify users, and new partners; begin designing service)	• **Work with Data Management Team to create clear and standardized documentation of existing GWF data collection, processing and preservation processes.** • **Work with Data Management Team to ensure a complete inventory of GWF datasets and locations** • **Support management in additional financial resource mobilisation** • **Identify staff training needs.** • **Reconstitute and redirect the GWF User Advisory Panel (UAP)** • **Work with UAP to develop user profiles.** • **Meet with expanded UAP to explain activities and tasks** • **Work with Outreach to hold awareness/familiarisation workshop/webinars to get lessons learned** • **Create user and collaborator/partner database structure and begin populating with existing data** • **Organise user requirements identification/verification process (workshops, surveys, interviews, webinars) for interactive web portal (data discovery and requests).** • **Create staff training plan**
Following two months	• **Review and test web portal with users** • Begin staff training. • Outline environmental scanning process and responsibilities.
Following three months	• **Revise web portal structure and content and retest with users** • Evaluate in-person service structure.
Following month	• Review of progress and drafting of annual plan

References

Global Commission on Evidence to Support Societal Challenges. 2023. “Strengthening Domestic Evidence-Support Systems : Procedures for Conducting Rapid Evidence-Support System Assessments (RESSAs).” (January 2022).

Appendix B: GWFO Outreach Strategic Plan

Outreach Strategy

Global Water Futures Observatories

February 14, 2025

Background

This document outlines the outreach strategy for the Global Water Futures Observatories (GWFO) network. The strategy will be implemented by the Outreach Specialist working in close collaboration with the GWFO secretariat under the guidance of the GWFO Director of Operations and Science.

The Global Water Futures Observatories (GWFO) is Canada's premier national freshwater research facility. It operates 64 instrumented basins, lakes, rivers, and wetlands, 15 deployable measurement systems, and 18 state-of-the-art water laboratories that monitor Canada's drainage basins and aquatic systems in unprecedented detail at a national scale, across seven provinces and territories, including the Great Lakes Basin and six other major river basins.

GWFO's vision is to operate a national water observatory consisting of a network of instrumented water observing sites, supported by deployable observing systems and major laboratories, that provides open access water data and the necessary infrastructure to collect supplementary data, which informs the development and testing of water prediction models, monitors changes in water sources, underpins diagnosis of risks to water security and helps design solutions to ensure the long-term sustainability of Canadian water resources.

Led by the University of Saskatchewan and eight other universities, GWFO collaborates with Indigenous communities, governments, industry and agriculture to support water services and management. It supports transformative water research that improves agricultural water management, water supply forecasts, river and lake health monitoring and develops advanced capabilities to predict water futures for Canada in a time of rapid global warming.

Outreach Objectives

The following outreach objectives and priorities have been identified for Global Water Futures Observatories:

- Plan, implement, and measure the success of comprehensive and strategic outreach projects to raise awareness and acquire users for GWFO data, facilities, deployable systems, and laboratories. Target audiences will include, but are not limited to, the academic and research communities, non-profit organisations, industry, government organisations, communities and municipalities, teachers, indigenous communities and organisations, and the public. The focus

will be primarily on Canadian audiences, with some international reach to other cold region countries.

- Develop and disseminate impactful stories, testimonials, and educational materials based on GWFO data and facilities, or a user's experience with GWFO. Such materials could be focused on, but not limited to, GWFO's role in monitoring Canada's water resources for water-related disasters or events, supporting the advancement of water-related sciences, informing water-related policies, predicting Canada's water futures, and educating/informing the public on Canada's past, present and potential future water situations. The dissemination of these stories, testimonials, and educational materials will be through websites, social media, printed materials, videos, webinars, etc.
- Work in close collaboration with the GWFO secretariat and facility leads to ensure consistency of GWFO outreach activities and messaging across all GWFO platforms and facilities.
- Work in close collaboration with the Knowledge Mobilisation Specialist to ensure outreach and knowledge mobilisation activities are complimentary, efficient, and effective.
- Liaise with the GWFO partner institution communications individuals to assist with disseminating strategic messaging and media-worthy stories from the use of GWFO data or facilities.
- Liaise with GWFO staff (technicians, lab managers) to develop stories, blog posts, etc. highlighting the unique features, capabilities, or advancements of their GWFO facility or site to encourage more users.
- Strategic participation in water-related conferences, workshops, events across Canada to showcase the strengths and benefits of the GWFO network and facilities. This could be through exhibitor booths, presentations, etc.

Key Audiences

The outreach strategy aims to engage with a wide range of audiences and will vary depending on the outreach activity being implemented. The key audiences include:

- Academic and Research Communities
- Non-Profit Organisations
- Indigenous and Non-Indigenous Communities & Municipalities
- Policymakers and Government Organisations
- Transboundary organisations
- Industries
- Primary and Secondary School Boards and Teachers
- Youth Organisations
- Outdoor Enthusiast Organisations
- General Public

Key Messages

- **Canada's premier national scientific freshwater observational and analytical facility** that sustains a legacy of freshwater observations and scientific infrastructure investment in Canada that goes back decades.
- **GWFO is an integrated "big data for water" facility that provides urgently needed scientific data to support flood, drought, water quality, and water management solutions.**
- **Open access to meteorological, glaciological, hydrological, water quality, and freshwater data** from 64 instrumented sites with records going back up to 50+ years (in some cases).
- **GWFO maintains a legacy of research sites and data that are** invaluable for the monitoring and detection of hydrological and water quality changes, and for developing in-depth understanding of the physical and biological responses to climate change and human pressures.
- **GWFO provides free access to a network of instrumented sites and access to state-of-the-art water laboratories and deployable systems (e.g. drones, vehicles, remote equipment, etc.) through a fee-for-service structure.**

Channels and Tactics

1. **Personal contact with GWFO staff**: Connect with GWFO technicians and lab managers to stay up-to-date about achievements, outcomes, etc. from their facility, laboratory, or instrumented site.
2. **Website:** Work with GWFO Digital Services Coordinator and Data Management team to ensure website content is up-to-date, accessible, and clearly organized. Including: GWFO-derived content, media stories, publications, user stories, etc.
3. **Email Campaigns**
    - **Newsletters**: Send quarterly e-newsletters to subscribers, highlighting upcoming events, success stories, opportunities to be involved with GWFO, GWFO facility/observatory features, etc.
    - **Targeted Emails:** Regularly connect with various individuals and organisations that may be interested in engaging with GWFO or sharing GWFO-related opportunities with their organisations/communities.
4. **Content Creation**: Develop various forms of digital and print material that highlights and advertises GWFO facilities/observatories, shares success stories of user's experiences, or ways that GWFO data/facilities have supported major campaigns, projects.
5. **Media:** Track media stories that feature GWFO facility leads or staff. Promote or pitch newsworthy stories to media contacts, including liaising with communications members at GWFO partner institutions.

6. **Social Media**: Utilize platforms such as LinkedIn, X, BlueSky and Instagram to share engaging content, including success stories, infographics, features, videos, and more. Use relevant hashtags to increase engagements (such as #GWFO). Existing GWF social media channels will be leveraged to maintain the large following already amassed.
7. **Events**
    - **External**:
        - Attend major water-related conferences and events across Canada to promote GWFO facilities and observatories. This could be achieved through exhibitor booths or presentations.
        - Lead or facilitate outreach or information exchange events with user groups.
    - **Internal:** Lead or facilitate the planning of GWFO-led outreach events with all types of audiences. Coordinate with partner institutions and users when beneficial.

Monitoring and Evaluation

1. **Track Engagement Metrics:** Monitor social media interactions, email open rates, website traffic, and event attendance to gauge the effectiveness of outreach efforts.
2. **Feedback Mechanisms:** Collect feedback from participants and stakeholders through surveys and direct communication to understand their needs and preferences.

By implementing this outreach strategy, the Global Water Futures Observatories can effectively raise awareness, foster collaboration, and drive meaningful action towards sustainable freshwater management. Continuous evaluation and adaptation of the strategy will ensure its success and long-term impact.

Appendix C: GWFO Data Management Strategic Plan

GWFO's Data Management, Research Security and Cybersecurity Policies

Data management (DM) strategies are issues of crucial importance, as these data represent a considerable investment of time, money, and resources. The long-term legacy of data from the programme can only be assured by its careful deposit in repositories and indexing in a centralized service. These issues have received a great deal of thought and attention since the inception of GWF and is adopted by GWFO.

The GWFO DM core team and GWFO's data policy.

From GWF's inception, the critical importance of DM was recognized and a core team of dedicated professionals was assembled to promote and govern the management, retention, use, and dissemination of data collected as part of GWFO's observation and analyses activities (https://gwf.usask.ca/people/core-teams/data-team.php). The team includes staff from five universities with oversight and direction from experienced faculty representatives at these universities, as well as high-level guidance from the SMC. Early in the programme this team prepared detailed plans and a sound strategy for DM with the following overall objectives:

1. Ensuring management of data throughout the acquisition–quality assurance and control–access and utilisation–preservation and archiving lifecycle;
2. Establishing data governance practices and processes;
3. Developing techniques and tools for data stewardship; and,
4. Providing input and assistance on all data-related initiatives of GWFO.

At the same time, the **GWFO Data Policy** was established to assist researchers in meeting the GWFO commitment to make data generated through the programme available to others by following data stewardship guided by the FAIR (Findable, Accessible, Interoperable and Reusable) principles (https://gwfo.ca/data/data-policy.php#GWFODataPolicy). This policy was carefully developed with the intention that it is sufficiently flexible to accommodate the multi-disciplinary nature of GWFO-funded activities and the wide variety of data collected therein. It adheres to the principle that research data collected with public funds should be publicly accessible, with a special obligation to openness and accountability, subject to overarching principles of data ownership, sovereignty, and privacy.

GWFO is fully committed to ensuring that the unique rights, interests, and circumstances of the First Nations, Métis, and Inuit are acknowledged, affirmed, and implemented. The data policy is explicit in requiring that research projects working with Traditional Knowledge must not compromise the rights of the knowledge holders. Research involving Traditional or Indigenous knowledge must adhere to the concepts of respect, reciprocity, and responsibility. This includes the "appropriate engagement of Indigenous People, communities or organisations throughout the entire data life cycle, formal attribution of contributed knowledge, establishment of informed consent for use of knowledge and derived products, and the maintenance of contributor control of data and information resources".

All GWFO-funded activities must adhere to the data policy as a condition of their grant and for the continuation of funding, including adhering to detailed project DM plans. The DM team engages with facility leads, managers, and technicians from each of the individual facilities to assist with ongoing DM tasks and priorities, providing technical assistance and support in various aspects of data processing, quality assurance and control, and archiving.

The DM systems and approach.

GWFO has adopted a distributed data preservation and access model that leverages existing, trusted repositories which meet GWFO data stewardship criteria and can be searched and accessed from a centralized metadata search portal. To ensure long-term, ongoing public accessibility to large volumes of complex and disparate data and associated information, a new tool, GWFNet has been developed as a user-friendly high-level information hub specialized for relating together different forms of records on water observation, analysis, and research. This ranges from special index records used to form hierarchical categories of information, to records on research groups, datasets, hydrological model workflows, basins, observatories, stations, measurement locations, and key researchers and their specialties. External links point to other websites, wiki pages, federated repositories, and other catalogues containing information (such as records in the Gordon Foundation's DataStream, GitHub, FRDR) and the links are contextualized by both the contents of the records and by how they are related to other records in the catalogue. GWFNet enables a variety of information seekers to easily zero in on trails of information and be able to obtain publications, datasets, data, and other related information that delivers context to the results associated with their search.

GWFNet has four simple but distinguishing features that differentiate it from all other information systems suitable for Water Research and allows it to simultaneously satisfy all the requirements of the Data Policy and GWFO to build a world-class information resource: 1) user-defined templates; 2) adaptive database; 3) cross-referencing; and, 4) automatic index creation. This system is designed for two core DM needs in GWFO and water research in general, 1) to aid modellers who wish to ingest data for river basin modelling and other purposes and, 2) to aid observational scientists in providing metadata and making datasets available for the system. The system provides enhanced capabilities that water research requires for DM such as river basin searches and will provide a longer and broader utility beyond GWFO.

In parallel, GWFO has begun to develop natural language processing and information retrieval techniques based on artificial intelligence (AI) to create a novel search tool that encompasses publications and metadata from the GWFO facilities and other data indexed by GWFNet. This new effort builds on AI techniques for analyzing scientific texts using the latest neural ranking models to provide information access. This will result in an intuitive search and browsing interface for output from the GWFO, including scientific articles and the textual metadata records associated with data products. This AI search portal will incorporate advances in neural network models based on transformer architectures.

DM activities and legacy.

The DM core team provides training sessions, a webinar series, and presentations to increase capability on DM practices, tools, and policy. Work continues to develop resources and strategies

to build data management capacity within our observation, analytical, and research community and support this cultural change within academia. The DM team liaises strongly with the Canadian research data management (RDM) community to build relationships and exchange knowledge and practices. For instance a joint water quality DM template has been developed with the Gordon Foundation DataStream (https://doi.org/10.5281/zenodo.4697621, https://doi.org/10.5281/zenodo.4697647, and https://assistant.portagenetwork.ca/). Further, GWFO Data Managers serve as members of the Data Management Planning Expert Group, and the DMP Assistant Steering Committee of the Digital Research Alliance of Canada, an organisation which also has an integral role in the implementation of the March 2021 Tri-Agency Research Data Management policy.

In addition to general data management advocacy, GWFO Data Managers have also served on the Leadership, Steering and Data and Information committees of the Smart Great Lakes Initiative (SGLi), a trans-national group of organisations led by NOAA's Great Lakes Observing System (GLOS) united in advancing the team developed Common Strategy for Smart Great Lakes to help stimulate and support Science, Data and Policy in the Great Lakes Region. Similarly, GWFO has worked with the Gordon Foundation in support of the Data Stream portals sharing water quality data and with some researchers adopting the DataStream standard and contributing to the portal. This association has also led to work being initiated to help define standards for microplastics data. The development and support of Communities of Practice and Data Standards will be key in harmonizing data structures and enhancing the accessibility of observatory data to drive solutions.

GWFO is planning to lead a special issue of the journal *Earth System Science Data* (https://www.earth-system-science-data.net/) to publish GWFO datasets, complementing special issues on Canadian cold regions observatories (https://essd.copernicus.org/articles/special_issue901.html) and high mountain research catchment data (https://essd.copernicus.org/articles/special_issue871.html) that have recently been completed.

GWFO has completed robust plans and a coherent strategy for DM in water sciences and is leading the RDM community with guidance, lessons, tools, and practical advice as well as developing a legacy metadata site, GWFNet, and novel AI-based search engine project. We have previously published an article in the international journal *Hydrological Processes* called "Ten Best Practices to Strengthen Stewardship and Sharing of Water Science Data in Canada" (https://doi.org/10.1002/hyp.14385). This is based on experience from the previous GWF programme and provides invaluable information and materials to base GWFO DM activities and for the global community.

Research security and cybersecurity policies.

GWFO and its core secretariat, DM team, facility leads, managers, and technicians across all partner universities abide by USask's established IT Security Policies and Procedures (https://itsecurity.usask.ca/resources/it-security-policies-and-procedures.php). Key elements of this policy are that i) All IT services, where practicable, to be administered by Information and Communications Technology (ICT) staff and hosted in secure facilities (e.g., university data centres or vendor-hosted facilities), and ii) All university-owned IT end-point devices, where practicable, must use services offered by ICT to ensure compliance with the published USask IT security

procedures. To the extent that the primary means of reducing and mitigating IT security risks is not practicable, the secondary means is for the unit or individual to work with ICT to implement alternative mitigation strategies to ensure that the overall risk to the university is being maintained at an acceptable level. Our DM team and technicians are directly engaged with the USask ICT. Our DM and visualisation and decision support systems are built with key platform qualities, including that they are sustainable, scalable, usable, open, and secure. End users are connected through a secured web service to provide them with better support, training and collaborative space for improved knowledge transfer. Secured user accounts are used to provide support for requests, grant permissions for various working environments, and allow users to securely upload and visualize their own data.

The GWFO data policy advocates both a centralized DM system for certain common data types that are needed for model applications, and a distributed data preservation model where researchers may securely deposit their data into reliable and trusted repositories with strong metadata management and description principles, persistent URL's (DOI's), and a robust search capability. GWFO can thereby mitigate stakeholder data deposit conflicts, reduce its operational costs, ensure the long-term preservation of its research data with trusted partners, and still develop a robust, searchable index of data. This alleviates risks of cyber-security threats, broken links, or incomplete/incorrect metadata description.

Appendix D GWFO Data Policy

Date Approved: 2024-11-25

GWFO is a provider of pan-Canadian, high-quality water research data from academic institutions and partners that is partly supported by the Canada Foundation for Innovation's Major Science Initiatives (MSI) Fund. As such, all data generated through the routine operation of the GWFO facilities (research sites, laboratories, and deployable systems) that are paid for by GWFO are governed by this policy and are regarded as GWFO-owned, open data, meaning that the data are machine readable, freely shared, used, and built on without restrictions (including for commercial purposes) under a Creative Commons CC_BY 4.0 License.

Routine data collection includes all observations (automated and/or manual, continuous and/or intermittent) as part of the GWFO supported functioning of the instrumented sites, laboratories, or deployable systems, including, but not limited to hydro-meteorological conditions, cryospheric observations, water quality/quantity, ecological/biological parameters, contaminants, or other water-related variables. These data are fully GWFO-owned. All such data shall be made available free of charge through web services, internet downloads, special requests, and through other internet and user-based access tools, and shall be catalogued in the GWFO central data catalogue, GWFNet.

The metadata in central catalogue shall offer centralized and well-organized access to all GWFO-owned data outputs by providing direct web links to download the data from the actual online database or other long-term repository system where the data reside, as well as links for instant visualisation. The central catalogue will also track data access requests for reporting to MSI.

GWFO may offer data owned or co-owned by one or more data partners which may be subject to alternative licensing depending on the established agreement between the partners. For instance, data may be collected from observation sites on Indigenous lands, and these data may be co-owned and subject to additional or alternative licensing and/or protocols, such as OCAP and CARE, which may supersede the CC_BY licensing depending on the agreements made with the partners.

GWFO may collect, store and deliver data owned by others through various collaborations and fee-for-service arrangements. GWFO encourages these owners to follow this GWFO policy.

All forms of data access (WISKI, FRDR, DataStream, etc.) shall provide a prominent link to the GWFO online Data Access Request Form for data users to complete and explanatory text urging users to complete the information and the reason for collecting this information. The information collected will be used to annually report the number of users of the GWFO data outputs along with the geographic and sectoral distribution of these users to CFI. Some GWFO hosted data may not be readily accessible through direct online download (e.g., very large size) and may require a special request to be submitted as described in the central catalogue.

This policy is implemented by GWFO following best practices described in the GWFO Data Policy Implementation Plan. The Implementation Plan is updated periodically as required to ensure that GWFO data management continues to follow best practices.

Appendix E: User Advisory Panel Guidance and Feedback

Priority actions for GWFO data access based on common feedback from GWFO user Advisory Panel members, December 2024 – January 2025

Issues and recommendations: technical issues and design for useability

- A clear upfront statement about the nature of the GWFO resource as a catalogue that points to data and services hosted elsewhere is needed.
- More categorisation of the types of data and geographic origin available in GWFNet upfront would be helpful, so user can filter using those categories: a browsable list of data types available, those categories should focus on the core subject area strengths of GWFO data, e.g. Temperature, SWE, Phosphorus rather than an empty search box.
- About GWFNet has a little explanatory video that should be updated and shared much more prominently. A list of partner repositories up front would be good.
- More explanation up front about the role of GWF projects as they dominate the organisational structure of GWFNet. It seems to require prior knowledge, and there is not a clear path.
- Think about implementing 'skins' for each major audience type: the same back end but different interfaces.
- A plain language summary should come up for each record.
- More instructions as to how to use the search bar are needed.
- It would be good to have a dashboard that allows users to pull up summarized information about a particular location (site, watershed) and get, for example, time series for an observation. They would then use these data to compare with the industry results.
- Geographical location is a key element and should be better represented through metadata and maps. geographic metadata needs to be identified as such to avoid confusion with the use of geography in organisation names, for example. Improve geographic metadata as it is perhaps more important than topic metadata, and look into an interactive map where users can identify the region they are interested in. Review the emphasis on the list of basins currently supplied -- relevant to GWF research but maybe not to all users.
- Using the map should enable direct access to data and publications related to a location, without having to return to a search menu.
- There is a display problem with the GWF-CCRN Data Telemetry Sites. For telemetry, it would be better to have more content than just the logos of the organisations that provide the data. On the specific telemetry site pages, the user should be able to also see more information about the site location, e.g. latitude and longitude.
- Could WISKI be used to better integrate the data?
- Investigate APIs to allow interaction with other portals for users who want to extract and combine data.
- On the pages that describe the instrumented sites, more is needed that describes what is being measured there, e.g. temperature, precipitation, windspeed, etc.

- Telemetry data: possibility to download batches of data, not just one item at a time.
- In many cases user could not find the link to get to the actual data.
- GWFNet records contain too many acronyms that people cannot understand.
- Explain more clearly the procedures related to access to equipment and facilities.
- The user is forced to go back and forth to view stations, rather than following a logical series of steps to get where they want to go.
- Existing maps feature: look at GIS capability; reformat Map page to create more intuitive navigation.
- Make controlled vocabulary metadata preferred over free text in searches to improve findability.
- Reposition the GWFO Data Request Form so that it is presented whenever a user starts a search or browse in GWFNet: it is hidden in its present location.
- Include explanation of the function of the Data Request Form (an explanation to the effect that there is no cost or obligation but we would like users to fill to inform our long-term planning), and rename the form to something like 'Data User Information'. Include some legalese to make it clear that personal information is not shared. Make it necessary to fill the details on the form only once -- set up user accounts? The intended use section should have a better range of options. Consider including an option for the user to voluntarily respond to a question such as, “are you willing to take a brief survey to provide more feedback? Improve use categories pick list by adding categories and change from radio button to give users more room to indicate their choice. It might be useful to ask the user to also select a sector category (e.g. industry, government, university), as it might be difficult or time-consuming for GWFO to figure this out simply by looking at the affiliation organisation name or acronym when it wants to analyse the data collected.
- To track use of the site and catalogue, implement analytics. Assigning DOIs to all datasets will help with tracking.
- The mixture of datasets, publications, observatories, etc.in GWFNet needs more explanation and easy way to filter by these record types: the record type list currently available is challenging for the user. A high-level diagram at the beginning could show the relationships among these record types.

Issues and recommendations: partnerships with boundary organisations

- Develop active partnerships with organisations carrying out complementary work would increase the resource/s utility. For example, watershed groups and research institutes, and two categories of users that academics don’t often think of: media who would value packages info, and political decision makers and their support staff who are often looking for quick answers.
- Identify boundary organisations who are interested in the data to link with citizen science monitoring groups by sharing and interpreting specific GWFO data that are relevant to their work.
- Integrate other complementary datasets, such as those at the TRCA and at ECCA, understanding that these research quality data already have a location but including them in GWFO’s catalogue.

- GWFO observatories and the established relationships with northern communities and institutions are considered especially useful.
- Participate in public meetings organized by SaskWheat and other producer associations.
- Consider possible users such as Irrigation Saskatchewan and the Canada-Saskatchewan Irrigation Diversification Centre in Outlook, who contract researchers and should be providing advice based on sound data to government. Western Canada Water Conference, The Canadian Infrastructure Benchmarking Initiative (coordinated by AECOM), Canadian Water Network. Government of Manitoba Inflow Forecasting Group.
- Link to other services such as those being developed by ECCC and climate services portals.
- Support building data management capacity within communities, including training workshops for low-capacity users.
- Consulting engineers: few companies would take the time to search for datasets and be willing to take them on, as that might require extra work to integrate it into their existing tools and workflows -- ongoing partnerships with these potential users where intermediate tools are produced would be ideal.

Issues and recommendations: open access and influencing policy (promoting the relevance of scientific data in governance processes)

- The lack of uptake of scientific evidence by government at provincial level in formation of its policies is a big problem: focus on this.
- The issue of commercial use and retention of data produced for a fee needs to be further discussed. Look at options for relieving costs for users such as watershed or Indigenous organisations who want to access GWFO's fee for service facilities, perhaps getting government support for this.
- Work with networks and deepen connections
- Seek endorsements from trusted organisations: use organisations like the CWRA with its high practitioner membership to build awareness of the platform.
- Possible need for a bilingual site, since it is a national resource.
- Develop more understanding how to use 'research quality' data for broader education.
- The standards for collecting and handling the chemical data in GWFO were not close enough to those of ECCC, there was not enough metadata, and it was clear that the samples were not the product of the kind of long-term monitoring needed for their work.

Appendix F: GWFO Workshop on Observations and Data

GWFO Workshop on Observations and Data

October 23 & 24, 2024 on Zoom

Workshop Summary

The workshop was attended by 54 participants on day-1 and 41 participants on day-2. The purpose of this workshop was to bring together the GWFO facility leads and managers and the GWFO staff to better understand our observations and data systems. GWFO is a vast network across Canada and across nine different universities, with about 50 employees and dozens more faculty leads and others to keep the facilities operating. Since the Launch event in the spring of 2024, this was a chance to better assess where we are at, what we are doing, and to explore possibilities for improving sites and harmonizing and making more interoperable the diverse facilities that GWFO supports.

Day-1 included an overview of GWFO and its status and progress, and presentations summarizing the operations and data collection of the instrumented sites, deployable systems, and water laboratories at the partner institutions. Together, these provided a comprehensive review of all the GWFO facilities. There was a discussion period that followed, and some ideas for connecting people across the network, activities we might pursue, and opportunities for sharing expertise and knowledge were brought up:

- There are clear thematic groupings of observations that are apparent: hydrometeorology, lake ecosystems, flux towers, cryosphere, wetlands, forests, agriculture, urban areas, chemistry, and eDNA. Cross comparisons of specific measurement approaches would be worthwhile within these groupings, and it might be worthwhile to form sub-groups of the technicians and site leads to examine issues of compatibility, optimal approaches, and interoperability amongst these.
- There is tremendous innovation across the network and sharing these experiences would be useful. We can help each other in doing this and gain confidence that the approaches are better, and thereby improve the network and facility. Getting technicians into different sites beyond those they normally work at would be tremendously worthwhile.
- An NSERC CREATE proposal for GWFO was suggested, given the collaboration across the network. This is worth exploring by the SMC.
- Participants are encouraged to share any GWFO news, stories, media to Outreach Coordinator, Stacey Dumanski (stacey.dumanski@usask.ca) to put online and/or in the newsletter.
- The GWFO secretariat can support developing and promoting outreach materials for GWFO labs, facilities, or observatories. Contact Stacey Dumanski and/or Monica Morrison (Knowledge Mobilisation Specialist, monica.morrison@usask.ca) to learn more.

Day-2 was focused on data management and included presentations to explain GWFO's data policy and central data management system followed by overviews of the data management, QA/QC, storage, and access at the GWFO partner institutions. The discussions raised important issues about the extent to which we can centralize data management functions, distributed data storage and repositories, short and long-term data preservation (i.e., well beyond GWFO), standards and meta-data:

- We need to develop more efficient ways of gathering information on our data users and tracking data downloads and usage, and we need support from the data repositories to do this.
- We must be careful with external data archives and compilations (universities, NGOs, governments), which cannot ensure their long-term preservation. There are many examples of previous networks and initiatives where the websites, links, and data have become inactive or disappeared. Publishing our data with a DOI in a suitable, discipline-specific, and reliable repository is recommended.
- It was noted that it is important to standardize the way in which data is cleaned and how instrumentation is cared for across basins and universities. This needs to be well-documented. This is where technical teams (i.e. hydrometeorological) can get together and review best practices, common problems, flagging data, etc. Or with snow surveys—how are these done across sites? Across the vast GWFO domain, approaches have been developed over years, but there are still opportunities for sharing experiences.
- We should also be clear with caveats on real-time data, calibration, etc., and where we cannot standardize data and procedures.
- We can explore training courses on best practices for technical and DM teams. These could be put on by us or they could be external, and this is something for the SMC to consider.
- The DM team will continue to work on an effective data strategy for managing real time and near-real time data, getting our data out to user groups in a timely and useful manner, and ensuring the long-term preservation of data. Meanwhile, technical teams can work together in thematic areas to improve standards and best practices, and to share experience and insights.

Appendix G: GWFO Equity, Diversity, and Inclusion Strategy

GWFO EDI Vision: *To achieve excellence in water research in ways that challenge social, economic, and environmental inequities and embed the principles of equity, diversity, and inclusion in our work.*

Key Terms and Concepts

Anti-racism: requires people to make an active commitment to challenging racism and discrimination in all of its forms, in policy, practice, and interpersonal communications.

Diversity: Diversity is a relational concept; no one person can be diverse on their own. We are diverse in our identities, experiences, and relationships with each other.

Equity: Taking an equity-based approach to organisational development and research means continuously challenging historically accepted ways of doing things to give individuals the resources they need to be successful rather than giving everyone the same tools and support.

Equity-Seeking Groups: used by universities to recognize groups including women, Indigenous People, people with disabilities, and visible minorities underrepresented or marginalized.

Equity-Deserving Groups: shifts attention towards Black People, Indigenous People, People of Colour, Women, People with (dis)abilities, and LGBTQ2S+ People as deserving of representation and belonging rather than exceptions within the university.

Inclusion: relates to the quality of the experience that people have in their work environment (e.g., hiring process, research teams, classrooms, or offices). Creating an inclusive environment means anticipating that people experience the world differently and designing experiences to reflect these needs.

Intersectionality: a concept coined by American scholar Kimberlé Crenshaw that provides a prism or lens to understand how people's experiences of multiple and overlapping identities and systems of oppression impact their life experiences and opportunities.

Introduction

GWFO is Canada's premier national freshwater research facility, funded in part through the Canada Foundation for Innovation (CFI) and its Major Science Initiatives (MSI) from 2023–2029. GWFO supports critical water research to safeguard Canadian water resources in an era of rapid change. Water monitoring and research are at the core of environmental, social, and economic well-being globally. GWFO researchers are leaders in many academic disciplines that contribute to an in-depth knowledge of water research in Canada and internationally. Embedding the principles of equity, diversity, and inclusion (EDI) in the fabric of GWFO's operations and research is critical to achieving core objectives. GWFO's Strategic Management Committee (SMC) recognizes that systemic barriers to EDI in water sciences do exist and require tangible action to make lasting change. Successful EDI work will require active participation and engagement from students,

faculty, and staff across the network. Together we can connect people working within the network, external partners, and end-users of the data and research around a shared vision for EDI in water research.

The 2021-2023 Global Water Futures EDI Strategy, adopted by GWFO, includes three central pillars of engagement (Figure 1); Institutional EDI, EDI in Research, and EDI and Knowledge Mobilisation. These three pillars address how we work together as colleagues internally to GWFO (Institutional EDI), how we impact the world (EDI in Research), and how we build partnerships and communicate our findings (EDI and Knowledge Mobilisation). In addition, GWFO is committed to an intersectional approach to EDI that considers how power structures influence EDI when people hold multiple intersecting identities (e.g., age, race, class, gender identity, dis(ability), and more). Working together across such an extensive research facility provides a clear opportunity to accelerate knowledge sharing and implement EDI practices specific to an inclusive water research facility.

Institutional EDI: Working Together

GWFO includes many unique organisational policies, norms, and practices that inform how we work as a team. The objective of this section is to normalize implementing EDI practices as inclusive colleagues in water research. The protocols and actions are designed to build upon best institutional practices both external to and across the GWFO network. The protocols will serve as templates that partner institutions can adapt to meet their specific needs.

People

Recruitment: Introduces inclusive design principles that normalize differences in needs and experiences in the recruitment process. Seamlessly integrates information about e.g., family and caregiving, access for people with dis(abilities), religious and cultural inclusion, into the process.

Retention and Promotion

- **Performance Metrics Protocol:** Individual contributions are more likely to be underestimated if people are a member of an under-represented or systematically excluded group. Formalizing equitable performance measurement metrics reduces bias and supports objective measurement.

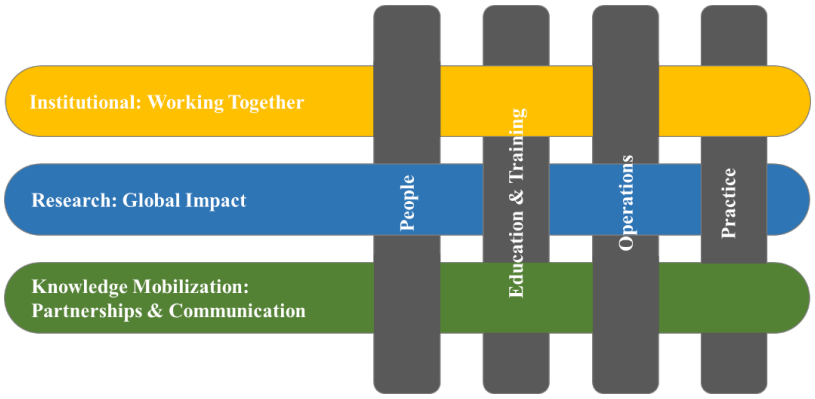


Figure 1. GWFO EDI Implementation Framework

- **Career Path Templates:** Career pathing for staff, including personal development goals and performance measures maps academic and non-academic career goals, measures performance, and creates dialogue to support career growth towards inclusive excellence.

GWFO YP Inclusion: Support young professionals (YP) using GWFO data to explore new ways of connecting with the facility and connecting incoming with fellow YP data users, sharing opportunities, and events to support inclusion and belonging. Recognize that significant barriers prevent YP from fully participating in water research; co-develop resources and activities to reduce systemic barriers in using the GWFO facility.

Exit Interview Template: The phenomenon of people in equity-deserving groups leaving academia at higher rates than cisgender, white males is well documented in academic literature. Reversing this trend requires practical knowledge of factors influencing exit to be addressed in real-time and to inform future decisions within the network.

Education & Training

Anti-Racism: Anti-racism is an active commitment. To change institutions, people must be actively anti-racist, a process that requires a personal commitment to learning and unlearning racist histories and practices.

Intercultural Communication: As teams and organisations become more diverse, it is essential to invest in learning communication strategies that help everyone to support open dialogue.

Interrupting Bias: A growing body of research finds that unconscious bias courses are ineffective because people have biases that training alone does not eliminate. Teaching skills to interrupt bias as it happens is demonstrably more effective at shifting organisational norms.

Psychological Safety: Creating an environment where people feel empowered to speak up about personal experiences is positively correlated with EDI, workplace satisfaction, and innovation.

Learning Resources: EDI is continuously evolving as a field of research. People and communities are also actively redefining language and priorities, which is why it is important to maintain a library of EDI resources specific to water research available to GWFO facility users.

Core EDI Training Module: Required for GWFO faculty, and staff to ensure that everyone working within the research program has a foundational knowledge of EDI principles.

Operations

Workspace Protocol: Accessible workspaces, both virtual and physical, are critical to EDI. Many university campuses offer student accessibility services; however, similar services may not be available to faculty and staff, particularly in off-campus settings.

Events Protocol: Conferences, events, and professional networking opportunities are often spaces where people experience a sense of belonging (or exclusion). Access to professional events and accessible events can profoundly impact career trajectories for technicians and data managers.

Procurement Protocol: Supports local, ethical, and environmentally conscious suppliers and provides established procurement arrangements for accessibility-related services (e.g., captioning, interpretation).

Practice

Case Studies: Useful tools to explore ethical dilemmas and evidence-based approaches to EDI in numerous contexts, including; northern research and international research collaborations.

EDI in Research: Global Impact

By strengthening GWFO members' capacity to incorporate EDI principles into fieldwork practices, methodologies, and community-engaged research, we can contribute even more through our work. With GWFO's extensive observatory network, there is also an opportunity to build capacity among the world's leading water researchers to mitigate the differential impact of empirical and theoretical research findings on marginalized people as a critical component of the research network's legacy.

People

Focus on Strengths: Provide information about accessibility and different paths to participation in water research. Build research teams that emphasize people's strengths, and the many ways people contribute to water research.

External Conference Participation: Conference and panel participation are significant opportunities to support EDI by being aware that your participation impacts others. Take into consideration the social, political, economic, and environmental impacts of conference participation and travel. Recognizing that EDI is context-specific and being asked to speak in many cases is a privilege, use your power as a water researcher to extend opportunities to others whose voices may be marginalized.

Education & Training

Research Protocol: Engage GWFO researchers in a conversation to develop an awareness of data disaggregation and potential research impacts, particularly as research outputs may differentially impact urban and rural communities, people of different socioeconomic status, people with dis(abilities), Black People, Indigenous People, People of Colour, LGBTQ2+ People, and more.

Operations

Fieldwork Protocol: Water research can often involve physically demanding work and long periods of fieldwork in extreme conditions that may be physically inaccessible. Health and family considerations may also pose temporary or permanent restrictions on fieldwork. Creating inclusive fieldwork environments welcoming people of all backgrounds and identities and free from harassment is critical to excellence in water monitoring and research.

EDI in Grant Applications: Equip researchers associated with GWFO with tools to connect their research program to evidence-based EDI practices and institutional.

Practice

Engagement: Where appropriate, engage local communities and youth in site demonstrations, citizen science activities, and co-created research.

EDI in Knowledge Mobilisation: Partnerships & Communication

Knowledge mobilisation and communication are an essential bridge between GWFO staff and our users. Incorporating EDI into knowledge mobilisation and communication in GWFO allows the facility to build on existing strengths, reach a wider audience, and amplify a diversity of voices, contributing to GWFO's effectiveness bridging gaps between academia and industry and facilitating inclusive policy advice.

People

Accessible Communication Protocol: Accessibility is a core component of both equity and inclusion. Taking practical steps to support accessibility helps to build strong partnerships, ensuring that people are not left out because the means of communication are inaccessible. Accessible communications strategies also provide GWFO content to a more diverse audience, further supporting knowledge mobilisation.

Education & Training

Equity, Diversity, and Inclusion (EDI) and Knowledge Mobilisation (KM) protocol: Provide additional training to GWFO staff to mitigate social, economic, and environmental inequities as they arise in monitoring and research. It is essential to support the secretariat, staff and site managers to identify power dynamics across the research facility.

Truth and Reconciliation in Water Research: Actively support staff to take up the recommendations in Towards Reconciliation: The 10 calls to action for natural scientists[i]. Provide ongoing opportunities for GWFO staff to learn about their responsibility to uphold Indigenous land rights, learn Indigenous languages and place names, and work with communities to develop mutually beneficial research.

Practice

Women+Water Lecture Series: GWFO will continue to increase national and international participation in this important GIWS initiative; expand the intersectional lens within the series, creating an inclusive community that champions women researchers exploring gendered impacts in water research, and young professionals.

Science Features: Encourage researchers to share knowledge with new audiences and make connections between scientific findings and social, economic, environmental, and health impacts. Explore different mediums for communicating to diverse audiences in accessible formats (e.g., YouTube videos, graphic art, and more).

Accountability & Evaluation

Data serve as an accountability measure for the presence and absence of diversity among water researchers. However, quantitative data are a starting point and not a destination. An active EDI strategy requires taking meaningful steps to establish a path forward for institutional change by

removing systemic barriers when and where they exist. EDI work must also broaden the focus from a quantitative understanding of EDI to a more dynamic and qualitative focus on equity and inclusion experienced in practice.

- **GWFO Engagement Survey:** Conduct regular engagement surveys that anonymously gather qualitative and quantitative data about sentiments of inclusion, experiences of equity and inequity, professional satisfaction, and intersectional measures of identity to guide actions that support inclusion and well-being.
- **EDI Dashboard:** An accountability structure that tracks progress in the organisational composition, funding, leadership, and research.
- **KM and Partnership Survey:** Incorporate an intersectional EDI lens into the KM evaluation process. Support learning from partner experiences and achievements in ways that contribute to GWFO's research legacy and inform new opportunities for KM and partnerships in future water projects and policy impact.

The language in this document reflects a certain time and place, Canada in 2025. The language used in EDI work is continually evolving to reflect the preferences of people and communities. Terminology and acronyms will be updated periodically to reflect this evolution.