

## Comprehensive Program Review – WATER SCIENCE

### General and Overview

1. Describe your program's most significant opportunities and significant challenges. The B.S. degree in Water Science is a new interdisciplinary major that was conceptualized by John Luczaj and Kevin Fermanich (Geoscience), in response to a call for new programs by Chancellor Gary Miller. The Notice of Intent was submitted in 2016, and final authorization to implement the program was given in May 2019. The official starting semester for Water Science was Fall 2019. As such, the majority of the content of this document is limited to early 2019 through August 2020.

Being a new program, the main opportunities and challenges revolve around curriculum development, engaging students and meeting enrollment targets, hiring new faculty, and building community partnerships. Water Science faculty include mainly 10 existing tenure-track CSET faculty members from other programs, two lecturers/research scientists, and a new tenure-track faculty hire (Kelly Deuerling, May 2020).

### **Opportunities**

- There are currently 9 declared Water Science majors as of Fall 2020. Our goal is to grow the number of majors to around 30-35 majors within 5 years.
- Along with existing course loads, growth will necessitate the hire of additional faculty, consistent with the planning documents approved by UW-System. This will be especially important due to bottlenecks in upper-level courses.
- Water Science will play an integral role in the new Freshwater Collaborative of Wisconsin <https://freshwater.wisconsin.edu/> This is a partnership of Wisconsin's 13 public universities with a stated goal to make the state of Wisconsin a global leader in water sciences training, research, and innovation.
- We should build a more robust set of field and laboratory equipment, a well field, and other state of the art tools to benefit student training and research.
- Participate in the conceptual development a "Aquatic/Water Research Center" at UW-Green Bay for water related research activities. (at conceptual stage now)
- Contribute to establishing the Green Bay National Estuarine Research Reserve.
- Provide more travel and funded research opportunities for Water Science majors.
- Continue to provide high quality outreach to the greater community.
- Faculty development and mentoring of new tenure-track faculty members

### **Challenges**

- Recruiting of students from high schools and additional locations is crucial, and this requires proper advising, marketing, and word-of-mouth because "Water Science" is not a traditional major that students expect in a list of majors. The non-traditional title for the major might pose its own challenges due to student perceptions.
- Cross-listing of courses was not allowed during the design of the major for existing water-based courses in other majors, and the inflexibility of the UW-Green Bay website may allow misperceptions about the program's offerings because only a few courses exist with Water Science prefixes (really only 3 that count toward the major).

- Transportation for field trips is costly, but rewarding.
- Funding adequate onsite resources, such as a deep well and a finished shallow monitoring well-field here on campus. This will require around \$10-12,000.
- Adjusting the curriculum to meet student schedules, content gaps, and other changes.

2. What are some things that would help make your program and its students more successful? (Narrative)

Several initiatives could make the Water Science program and its students more successful. First, the fall 2020 – spring 2021 **marketing campaign for Water Science** is a great start that we hope will be effective. Second, **scholarships** directed at Water Science students could be very effective at drawing students into the program. Third, once a critical mass of students is reached, development of one or more **student organizations** would lead to a greater sense of community among students. Additional assistance **recruiting from high schools** would also help, but is currently unavailable. **Additional undergraduate research funds** should be made available for student research throughout CSET, similar to opportunities available at some other UW campuses, which would help students conduct high quality high-impact practices. For many projects, \$1000 to \$2000 is needed for to conduct the research because of requirements for travel, outside chemical or isotopic analysis, or consumables. Finally, some **internal analytical instrument upgrades** or access to tools we presently do not have would greatly enhance the ability of students to conduct research on campus. These upgrades should include repurposing of existing lab spaces to provide focus and continuity for water-related student research projects.

3. What are some program accomplishments worth highlighting? (Narrative)

Because it is a new program built mainly from existing faculty in other programs, Water Science accomplishments are difficult to measure because of overlap with other programs. Water Science faculty provide strong contributions in teaching, service, and scholarship. Some of the highlights for water science include:

- High enrollment during the first regular semester course offerings (80 students enrolled in Water 201 for Fall 2019 and Fall 2020), with a summer 2020 offering.
- Students have already engaged in independent research projects.
- Dr. Kevin Fermanich was selected by the Green Bay Water Utility and NEW Water for their Watershed Champion award (March 2020).
- Lakeshore Water Institute (Manitowoc; Drs. Hein, Abler) formalizes research and community collaborations developed over the last several years, make us more competitive for external funding, expands the scope of the work to other disciplines, and attempts to make the work sustainable well into the future.
- Extensive outreach that includes media interviews, Water Science summer camps (summer 2019, summer 2020 cancelled due to Covid-19), and presentations organizations including Lifelong Learning Institute (LIR), DNR CAFO Workshop, Wisconsin Land & Water Workshop, etc.

4. Have there been any significant changes that have affected your program? (Narrative)

The program is new, so the changes that have affected the program align with normal development:

- Hiring of Dr. Kelly Deuerling for Fall 2020 was the most significant change.
- Going forward there is new uncertainty with new “All-Sciences” state teaching licensure for science teachers that should be completed in 2021. There is the potential for expanded interest in Water Science majors, depending upon the final requirements enacted by the state.

5. Where do you want your program to be 5 to 7 years from now? (Narrative)

Water Science is in the building phase. As such, the principal goal is to **increase the number of majors**. An ideal number of majors would be in the 25-40 range from our current 9 majors. While the precise interest in the program is unknown, we believe Water Science is well situated to meet these targets because of projected national increases in employment in Water Science related fields (10-year growth rates of 10-25% in various water fields).

The Freshwater Collaborative of Wisconsin is likely to be an important factor in the development of the Water Science major. A growing major will likely require additional faculty, some of which might be funded through FCW, along with scholarship money and grant funding, assuming that funding of this initiative continues.

We anticipate growth in our water focused partnerships with industry, NGO, and government throughout the region and that there will be a growing number of internship, student employment and project opportunities for our students.

Relatively soon, we would like UW-Green Bay to become a university member of CUAHSI (Consortium of Universities for the Advancement of Hydrologic Science). University affiliation requires a one-time initiation fee of \$2000, plus dues of \$200/year. This would give us more visibility and opportunities for collaboration and the ability to have students participate in their collaborative university courses.

Long-term, we anticipate participation in the establishing of the Green Bay National Estuarine Research Reserve, which has already begun and will be a several year-long process. Additionally, an idea that is at the conceptual stage at present involves the development a “Aquatic/Water Research Center” at UW-Green Bay for water related educational and research activities, partnerships, and resources.

### **Demand**

*All data in this area is provided with the materials. (Graduates, majors, minors, etc.) This space is for any commentary you would like to apply to that material. (Narrative)*

As it is a new program, Water Science has not yet had any graduates, but we anticipate our first graduate in Spring 2021. Despite only being 1.5 years old, and having little attention from Majors Fairs, open houses, etc. due to Covid-19, we have 9 majors at the present time.

We anticipate that demand will be high for the Water Science major, based upon internal surveys of UW-Green Bay students, as well as the national employment outlook in the water sector. During 2017, UW-Milwaukee did an Exploratory Study of Water-related Workforce Needs for

Wisconsin. The survey, which focused on water professionals in southeastern Wisconsin, indicated that over 70% of the 114 respondents anticipated that their organization would be hiring water-related professionals in the next three years.

### Internal

#### 1. Program goals (Mission, vision, learning outcomes; present as narrative/lists)

The B.S. Degree in Water Science contribute directly to the mission of the UW System by preparing our citizens to face the water-related challenges of the 21st century. The program matches the university's Select Mission through its commitment to excellence in teaching, scholarship and research, and service to the community and by providing an interdisciplinary, problem-focused educational experience. It provides opportunities for collaboration in our region by greater engagement with businesses, non-profits, and governmental agencies. The program prepares students for career opportunities in private industry, water utilities, geotechnical consulting, natural resource management, state and federal government agencies, or environmental policy organizations. For students interested in pursuing graduate work, the program will help to set a solid foundation for students interested in UW Milwaukee's School of Freshwater Science graduate program or other programs nationwide. Water Science also plays a key role in environmental sustainability. Our graduates will promote the economic development of the state by working in private industry, government, and education. Our faculty also assist these three sectors by providing scientific expertise, training, educational presentations, and other resources. Relationships exist between Water Science faculty and USGS, US Fish and Wildlife Service, WDNR, Green Bay Water Utility, NEW Water, Manitowoc County Lakes Association, and other organizations.

#### WATER SCIENCE LEARNING OUTCOMES:

- 1. Students will be able to describe the role water plays in the lithosphere, hydrosphere, cryosphere, atmosphere, and biosphere, with emphasis on interactions between these reservoirs.*
- 2. Students will apply the scientific method to investigations of hydrologic processes, Earth systems, and interactions among the various physical and biological realms utilizing standard scientific field and laboratory methods.*
- 3. Students will demonstrate an understanding of the hydrology of streams and lake systems and the role water has in landscape-forming processes that act on the Earth's surface.*
- 4. Students will be able to describe the processes of and importance of groundwater flow and aquifer systems.*
- 5. Students will be able to compare chemical interactions that occur in various hydrologic settings and their importance to water resources, geological and biological systems, and water/wastewater treatment.*
- 6. Students will be able to describe the role water plays in atmospheric systems and the climate system.*
- 7. Students will be able to describe the interactions between water systems and ecosystems.*
- 8. Students will be able to describe the challenges of maintaining surface and ground water quality.*

- 9. Students will apply their knowledge base and research skills to current issues pertaining to water resources, management, and remediation, with emphasis on related economic, social, and public policy dimensions.*
- 10. Students will analyze, interpret, and report on laboratory and field findings using appropriate statistical techniques and computer applications.*

2. Curriculum development (Lists, brief narrative if appropriate)

The curriculum for the major is made up mainly of existing courses from other programs. A few new courses with the Water prefix were introduced as part of the roll-out of the major, and there were a few modifications to the curriculum during 2019-2020.

- Water 201 (Intro to Water Science) was a new course taught in Fall 2019 and Summer 2020 that serves as the gateway course for the major.
- Water 202 (Water Science Laboratory) was a new course developed at the request of the Dean of CSET, specifically for Summer 2020 for students that were seeking a natural science laboratory for the AAS Degree.
- Water 444 (Geochemistry of Natural Waters) was an upper-level course requirement in the major that was developed during summer 2020 and first offered during Fall 2020.

Other changes include:

- Environmental Systems was moved from the required core to the elective category to increase degree flexibility.
- Water 321 (Stable Isotopes in the Environment) was formally given a course number, although it had been taught previously under “special topics” in Geoscience, Environmental Science, and ES&P programs.
- Recently, a new “Accelerated Emphasis” was added (similar to several other NAS majors). Admitted accelerated students are eligible to enroll in up to 12 graduate credits prior to obtaining their Bachelor’s degree, and those credits can count toward the Environmental Science & Policy M.S. degree.

3. Connections to other programs (Lists, brief narrative if appropriate)

Water Science is intrinsically connected to several other programs. In most cases, Water Science Faculty have their primary assignment in other disciplines. In addition to the first Water Science faculty hire (Dr. Kelly Deuerling), the Water Science faculty list is comprised of individuals from Biology, Chemistry, Engineering Technology, and Geoscience. Water Science faculty also served substantial administrative roles during 2019-2020, including 1 associate dean (half-time), 2 Departmental chair, 3 graduate chair positions, and 6 unit chair positions. During the review period, the only courses offered with a Water Science prefix were taught by John Luczaj. Most of the required courses in the major have course prefixes in other disciplines.

The Water Science major will also be linked with the newly developed Freshwater Collaborative of Wisconsin (FCW). <https://freshwater.wisconsin.edu/> This concept will link students and faculty across multiple campuses by sharing resources to provide a

more efficient array of course offerings and research opportunities for students and faculty.

Additional connections:

- Contributions to the Environmental Science & Policy Graduate Program
  - Water Science courses (Water 321/596 and Water 644) will have graduate student enrollment as electives for students.
  - Water Science faculty serve as M.S. thesis advisors and committee members for graduate students in the ES&P program.

4. Number of courses offered (Overall number provided in materials. Chairs: short commentary if appropriate. Provide a sub-grouping of various modalities by percentage. For example, what percentage of your program is available online, hybrid, etc.?)

In addition to independent study and internship courses, there are only 4 specific Water Science courses, one of which does not count toward the major. At present, two faculty teach courses with the Water Science Prefix (Luczaj and Deuerling), along with courses in other programs. Faculty associated with Water Science program teach a wide variety of courses in their home disciplines, including Biology, Chemistry, Geoscience, and Environmental Engineering Technology, some of which are taken by Water Science majors, but many of which are not.

Aside from Covid-19, the Water Science major is 100% face-to-face, with a substantial number of field and laboratory experiences. We might offer an optional online section of Intro to Water Science after the Covid-19 crisis subsides, but that has not yet been determined.

5. Diversity of students, faculty, and curriculum (Overall number provided in materials. Chairs: short commentary if appropriate; provide examples from curriculum if appropriate.)

No data are available for graduates, but 1 of 9 students indicated an ethnicity other than white. Only 1 of 9 students identified as female, which is inconsistent with the student body at UW-Green Bay. At this point, it might be the small sample size that is affecting these ratios.

6. Gen Ed, FYS/GPS, CCIHS (Lists)

- Two Water Science courses satisfy general education requirements, including:
  - Intro to Water Science – Water 201 (*Sustainability requirement*)
  - Water Science Laboratory – Water 202 (designed for AAS students for a lab credit requirement; online)

7. Program support and staffing (Chairs: History, trends, and future needs. Depending on program, could be connected to accreditation.)

Program support has been adequate, as shared resources for NAS/CSET have worked well. The rollout of the new Water Science major was accomplished through overloads and the May 2020 hire of Dr. Kelly Deuerling. We anticipate the need for future faculty

as the program grows because bottlenecks may occur in several upper-level courses. This was planned for in the documents approved by UW-System. If successful, the rollout of the Environmental Science major at the Manitowoc campus might lead to an offering of Water Science as well in a few years. In addition, participation in the Freshwater Collaborative of Wisconsin might necessitate additional programs, and external funding might be available. The precise need for new faculty or research staff is unclear at the moment.

8. Cost per credit hour (TBD)  
 Uncertain what to put here.

### External

1. Outreach: student/faculty partnerships, collaborations, participation with organizations or individually (Lists)

The list of outreach activities related to Water Science faculty is extensive and includes interactions with the community and with industry, governmental, and educational organizations. Some examples include:

- The Lakeshore Water Institute - created to formalize the collaborative partnership between the University of Wisconsin-Green Bay, Manitowoc Campus and the Lakeshore Natural Resource Partnership (LNRP).
  - GEAR UP summer camp on Geology/Water Science in 2020. (Camp cancelled)
  - Virtual Water Science Field Trip; used in Water Science 201 course (available to the public on YouTube): [https://www.youtube.com/watch?v=bc1J9N\\_PbTk](https://www.youtube.com/watch?v=bc1J9N_PbTk)
  - Lake Largo Management and Outreach Team
  - Manitowoc County Lakes Association (MCLA)
  - Farmory Hatchery Subcommittee
  - Summer camps such as Environmental Science (for Oneida Nation) in 2019, GBAPS Water Science camp in 2019, and Gear Up (cancelled for 2020 due to Covid-19)
  - Presentations to Lifelong Learning Institute (LLI/LIR) and other organizations.
  - Service to organizations such as American Water Resources Association, Lower Fox River Watershed Monitoring Program, Technical Advisory Committee, Brown County, Lower Fox Demo Farms Network Advisory Committee and Soil Health subcommittee, Save the Bay initiative, Great Lakes Climate Adaptation and Resilience Workshop, and others.
  - Frequent contact with community members seeking assistance with water flooding problems, well water quality questions, and other inquiries about water.
2. Contributions to regional infrastructure (Lists)
- Water Science is a new major, so no students have yet graduated. We anticipate that our graduates will play an important role in serving the regional employment in key infrastructure areas, such as water resources, regulatory agencies, environmental consulting firms, private industry, and education.
  - Water Science faculty are **regional experts** in many areas, and as such are sought out by farmers, engineers, regulators, educators, NGOs, media, and others. Faculty are routinely interviewed by media organizations.

- Water Science faculty **provide training** for organizations such as the Wisconsin Land & Water, Wisconsin DNR, Wisconsin Water Well Association, UW-Extension, and Engineering societies for training and continuing education. While some of these examples are from before 2019, we anticipate continued service going forward.
  - Green Bay National Estuarine Research Reserve (NERR) Organizing Team
  - Hosted meetings of multi-agency Lower Fox River watershed monitoring work group.
  - Lower Fox River Planning Steering Committee service
  - Co-chair of Shared Measurements workgroup
  - **Partnerships** with local water utilities (Green Bay Water Utility, Village of Bellevue) to assist with well rehabilitation, water leaks, etc.
3. Scholarly activity of faculty (Lists that are not all-inclusive; maybe seek to highlight the different areas/types of activity)
- Water Science faculty have been very productive in terms of publishing peer-reviewed journal articles, internal and externally funded grants, scholarly presentations, books, etc. The research spans many subdisciplines in the sciences, so it is difficult to track precise project criteria, but most, if not all projects are water related.
- Water Science faculty have been associated with several internal grants and about **\$1.5 million in externally funded grants that were received during the May 2019 through August 2020 period.**
  - A patent was awarded to Prof. Zorn.
  - 25 oral and poster sessions at scientific conferences or symposia.
  - At least 8 peer-reviewed scientific articles, with many others in under review.
  - Several non-peer reviewed reports to funding agencies
  - Multiple journal volumes edited
  - Faculty served as thesis advisors for at least 12 graduate students.

### **Student Success**

1. High-impact practices and individualized-learning opportunities (Some data provided; lists and/or brief narrative)
- Many student experiences are HIPs in the Water Science program, and faculty contribute to a wide variety of internal and external individualized learning opportunities.
- Laboratories are required in many supporting and upper level required courses.
  - Required outdoor field trips in at least 6 of the courses required for the major, some of which are half-day or full-day trips.
  - Independent research opportunities in laboratory and field settings occur across a broad array of topics in Water Science. Many have led to conference presentations or peer-reviewed articles. **Two of these were formally Water Science 498**, but Water Science faculty supervised at least 14 independent studies in several disciplines during the 2019-2020 academic year.
2. Retention (TBD. Note: if program-level data is not provided, maybe list some things your program does that you believe aid in retention.)
- Not provided. However, of all 10 majors that have declared, 9 remain in the program, so 90% retention so far.

**Mission Relevant**

## 1. Relevance to mission (Narrative or lists as appropriate)

Water Science is the study of water and its interaction with solids, liquids, gases, and organisms in various Earth systems. Water is essential to life, and it plays a critical role in nearly every natural process in Earth's lithosphere, atmosphere, hydrosphere, biosphere, and cryosphere. Water is likely going to be the single greatest resource challenge of the 21st century. The global need for water science professionals to solve critical water issues is accelerating and expected to continue indefinitely. Recent examples include the lead contamination crisis in Flint, Michigan, the ongoing arsenic exposure in Bangladesh, and the water crisis in Cape Town, South Africa.

The B.S. Degree in Water Science will contribute directly to the mission of the UW System by preparing our citizens to face the challenges regarding water quantity, quality, and ecological function that are expected to worsen during the 21st century. The Water Science major has a strong fit with UW Green Bay's mission, strategic plan, and existing programs.

The Water Science program relates to the select mission of the University primarily through its emphasis on teaching excellence. The program takes an application-focused, interdisciplinary approach, in which physical, chemical, and biological processes are investigated as interacting systems. The Water Science curriculum addresses pressing environmental issues and encourages critical thinking, both in and outside the classroom. The Water Science program also contributes to the Select Mission through extensive community-based partnerships and collaborative faculty scholarship. It plays a key role in environmental sustainability, especially as it relates to surface water and groundwater quality, aquatic ecosystems, and soil health and agriculture.

For the Core mission, Water Science faculty have been prolific in scientific research, external granting, and community outreach. Our graduates will promote the economic development of the state by working in private industry, government, and education. Our faculty assist these three sectors by providing scientific expertise, training, educational presentations, and other resources to organizations such as USGS, U.S. Fish and Wildlife Service, DNR, LNRP, Green Bay Water Utility, NEW Water, and others.

## 2. Cultural enrichment (Narrative or lists as appropriate)

Water Science provides valuable elements of cultural enrichment. Water forms the essence of life, and most people feel a strong connection to water in our environment. Proximity to water bodies defines a strong sense of place, including the bay of Green Bay, rivers like the Fox and Menominee, Lake Michigan, and smaller lakes and streams. Water has played an important role throughout human history, and the upcoming documentary by Dan Larson on the Fox River Lock and Dam system features interviews from two Water Science faculty members (currently in production).

## 3. Access (Does the program have any agreements with other institutions? For example, a transfer agreement with a technical college.)

None, but early discussions have taken place with NWTC and Bay College in Escanaba, Michigan that we anticipate will lead to transfer agreements in the future.