

# **Water Science & Policy Graduate Program**

**2015 PSPR report for  
Permanent approval of  
MS Degree**

## **KEY SECTIONS IN REPORT**

(following guidelines at: <http://www.udel.edu/facsen/course/index.html#Final>)

- A. Academic Program Approval Form requesting permanent status
- B. Copy of Faculty Senate resolution granting provisional status
- C. Copy of the original program proposal that was submitted for provisional status
- D. Graduate program policy document
- E. Assessment of library resources available to support the graduate program as provided by the UD Library
- F. Self-study report
- G. Appendix

**A. Academic Program Approval Form requesting permanent status.**

# UNIVERSITY FACULTY SENATE FORMS

## Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. Detailed instructions for the proposal should be followed. A [checklist](#) is available to assist in the preparation of a proposal. For more information, call the Faculty Senate Office at 831-2921.

**Submitted by:** Shreeram Inamdar, Professor & Director phone number 831-8877

**Department:** Plant & Soil Sciences email address inamdar@udel.edu

**Date:** October 30, 2015

**Action:** Request for Permanent Status  
(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc.)

**Effective term** 2016F  
(use format 04F, 05W)

**Current degree** Master of Science (MS)  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed change leads to the degree of:** Master of Science (MS)  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed name:** Water Science and Policy  
Proposed new name for revised or new major / minor / concentration / academic unit (if applicable)

### Revising or Deleting:

**Undergraduate major / Concentration:** N/A  
(Example: Applied Music – Instrumental degree BMAS)

**Undergraduate minor:** N/A  
(Example: African Studies, Business Administration, English, Leadership, etc.)

**Graduate Program Policy statement change:** N/A  
(Must attach your Graduate Program Policy Statement)

**Graduate Program of Study:** Water Science and Policy  
(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

**Graduate minor / concentration:** N/A

**Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, either describing the new program or highlighting the changes made to the original policy document.**

**List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?**

(Be aware that approval of the curriculum is dependent upon these courses successfully passing through the [Course Challenge](#) list. If there are no new courses enter “None”)

None.

**Supply support letter from the Library, Dean, and/or Department Chair if needed**

(all new majors/minors will need a support letter from the appropriate administrator.)

See attached support letters from the four college Deans and Chair of the Plant and Soil Sciences Department.

**Supply a resolution for all new majors/programs; name changes of colleges, departments, degrees; transfer of departments from one college to another; creation of new departments; requests for permanent status. [See example of resolutions.](#)**

WHEREAS, the MS in Water Science and Policy was given provisional approval in September 1, 2011, and thus needs to gain permanent status, and

WHEREAS, the Water Science and Policy is a university-wide program supported by four colleges and the Delaware Environmental Institute and meets the goals of graduate education and fits the Path to Prominence, and

WHEREAS, Water Science and Policy program is a truly interdisciplinary program that prepares students to address water-related challenges that are not only scientifically sound, but economically viable, socially acceptable and environmentally sustainable, and

WHEREAS, the Water Science and Policy program has grown rapidly from zero to 20 graduate students in five years (including two that have graduated) and

WHEREAS, students who have graduated with a MS in Water Science and Policy have an excellent placement history in the environmental and water industry, and be it therefore

RESOLVED, that the Faculty Senate permanently approves the establishment of the MS in Water Science and Policy effective September 1, 2016.

**Explain, when appropriate, how this new/revised curriculum supports the 5 goals of undergraduate education: <http://www2.udel.edu/gened/>**

N/A

**Identify other units affected by the proposed changes:**

(This would include other departments/units whose courses are a required part of the proposed curriculum. Attach permission from the affected units. If no other unit is affected, enter “None”)

College of Agriculture and Natural Resources  
College of Arts and Sciences  
College of Engineering  
College of Earth, Ocean, and the Environment  
(support letters are included from Deans)

**Describe the rationale for the proposed program change(s):**

(Explain your reasons for creating, revising, or deleting the curriculum or program.)

Permanent approval required following 5-year provisional period for MS degree in Water Science &

Policy.

**Program Requirements:**

(Show the new or revised curriculum as it should appear in the Course Catalog. If this is a revision, be sure to indicate the changes being made to the current curriculum and **include a side-by-side comparison** of the credit distribution before and after the proposed change.) [See example of side by side.](#)

MS in Water Science & Policy – Course Curriculum (30 credits)	
Select 24 credits, with at least 3 credits from each category.	a) Physical Sciences
	BREG 623 Advanced Storm water Management
	CIEG 698 Groundwater Flow and Contaminant Transport
	GEOG 632 Environmental Hydrology
	GEOG 656 Hydroclimatology
	GEOG 651 Microclimatology (4)
	GEOL 628 Hydrogeology
	GEOL 611 Fluvial Geomorphology
	PLSC 603 Soil Physics
	b) Chemical/Biological Sciences
	BREG 621 Nonpoint source pollution
	BREG 667 Watershed Hydrochemistry
	CHEM/MAST 683 Environmental Chemistry
	CIEG 632 Chemical Aspects of Environmental Engineering
	CIEG 636 Biological aspects of Environmental Engineering
	CIEG 668 Principles of Water Quality Criteria
	GEOG 631 Watershed Ecology
	GEOG 667 Watershed Hydro-Ecology
	PLSC 608/CHEM 608 Environmental Soil Chemistry
	MAST 618 Marine Microbial Ecology
	c) Policy
	ENEP 626 Climate Change: Science, Policy and Political Economy
	ENEP 666 Topics in Sustainable Development
	ENEP 810 Political Economy of the Environment
	ENEP 868 Sustainable Water Policy Research
	ENEP 870 Sustainable Water Policy Readings
	GEOG 617 Seminar in Climate Change
	GEOG 649 Environment & Society
	MAST 672/ECON 670 Applied Policy Analysis
	MAST/ECON 867 Valuing the Environment
	MAST 670 US Ocean and Coastal Policy
	MAST 670 Legal Aspects of the Coastal Zone
	MAST/ECON 676 Environmental Economics
	MAST/UAPP 663 Decision Tools for Policy Analysis
	POSC 818 Environmental Politics and Policy
	UAPP 611 Regional Watershed Management
	UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)
	UAPP 628 Issues in Land Use and Environmental Planning
	UAPP 667 Field Seminar in Water Policy
	UAPP Environmental Policy Analysis
	d) Research Methods
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)
	PLSC 667 Interdisciplinary Seminar (1)
	CIEG 667 Research in Water Science and Policy (1)
	e) Statistics, Analysis & Techniques:
	CHEG 604 Probability and Statistics for Engineering Problem Solving
	FREC/STAT 608 Statistical Research Methods
	FREC 615 Advanced Prices and Statistics
	FREC/STAT 674 Applied Database Management
	FREC 807 Mathematical Programming with Economic Applications
	GEOG 670 Geographic Information Systems and Science
	GEOG 671 Advanced Geographic Information Systems
	MAST 681 Remote Sensing of Environment
	MEEG 690 Intermediate Engineering Mathematics
	STAT 657 Statistics for Earth Sciences
<b>Directed Research Option (3)</b> With advisor approval, MS students may opt to carry out directed research, in lieu of one course, within categories a, b, or c above.	
<b>Thesis (6)</b>	

**ROUTING AND AUTHORIZATION:** (Please do not remove supporting documentation.)

Department Chairperson \_\_\_\_\_ Date \_\_\_\_\_

Dean of College \_\_\_\_\_ Date \_\_\_\_\_

(By signing above, the Dean confirms that their college policies and bylaws have been followed correctly during consideration of the request described in this form.

The approval actions that were taken at the college level were (check all that apply) :

\_\_\_\_\_ college faculty vote; \_\_\_\_\_ college curriculum approval \_\_\_\_\_ college senate approval

Chairperson, College Curriculum Committee \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Com. on UG or GR Studies \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Coordinating Com. \_\_\_\_\_ Date \_\_\_\_\_

Secretary, Faculty Senate \_\_\_\_\_ Date \_\_\_\_\_

Date of Senate Resolution \_\_\_\_\_ Date to be Effective \_\_\_\_\_

Registrar \_\_\_\_\_ Program Code \_\_\_\_\_ Date \_\_\_\_\_

Vice Provost for Academic Affairs & International Programs \_\_\_\_\_ Date \_\_\_\_\_

Board of Trustee Notification \_\_\_\_\_ Date \_\_\_\_\_

Revised 9/22/2015/khs



**B. Copy of Faculty Senate resolution granting provisional status.**

# **REGULAR MEETING OF THE UNIVERSITY FACULTY SENATE**

**April 11, 2011 – 104 GORE HALL**

March 29, 2011

TO: Senators and Executives

FROM: Belinda Orzada, Vice President  
University Faculty Senate

SUBJECT: Regular Faculty Senate Meeting April 11, 2011

In accordance with Section IV, paragraph 6 of the Constitution, the regular meeting of the University Faculty Senate will be held on Monday, April 11, 2011 at 4:00 p.m. in 104 Gore Hall. [The General Faculty](#) meeting will be held this month as well. This meeting will begin at **3:30** p.m. just prior to the Faculty Senate meeting, and will also be held in 104 Gore Hall. Please make every effort to attend this meeting.

I certify that hard copies of the approval page for each undergraduate and graduate studies academic item on the agenda are filed in the Faculty Senate Office with the appropriate signatures of approval up through the Chair of the Faculty Senate Coordinating Committee on Education. The Agenda will be as follows:

# **AGENDA**

**I. Adoption of the Agenda**

**II. Approval of the Minutes:** [March 7, 2011](#)

**III. Remarks:** Provost Tom Apple

**IV. Announcements:** Senate President John Madsen

**a.** Marcia Nickle and Skip Homiak – Office of Campus and Public Safety

**b.** Larry White – Office of General Counsel

**V. Consent Agenda**

**1. Announcements for Challenge:**

- a. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the English major with Literary Studies concentration** (0075) ([revised 3-10-11](#))
  
- b. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the BEE in Electrical Engineering** (0044) ([attachment](#)) ([revised attachment 2-23-11](#))
  
- c. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Honors BEE in Electrical Engineering** (0045) ([attachment](#)) ([revised attachment 2-23-11](#))
  
- d. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Bachelor of Computer Engineering** (0046) ([attachment](#)) ([revised attachment 2-23-11](#))
  
- e. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Honors Bachelor of Computer Engineering** (0047) ([attachment](#)) ([revised attachment 2-23-11](#))
  
- f. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the BS major requirements in Mathematics Education** (0050) ([attachment](#)) ([support UNIV101attachment 2-11-11](#))

- g. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the BA major requirements in Mathematics Education** (0051)([attachment](#)) ([support UNIV101attachment 2-11-11](#))
- h. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the Middle School Science Concentration in the Elementary Teacher Education Major** (0015) ([attachment revised 2-23-11](#))
- i. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to delete concentration: Ecology and Organismal Biology within the Biological Sciences Major** (0072)([attachment](#)) ([attachmentemail](#))
- j. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the major in Early Childhood Education** (0039) ([revised attachment 3-10-11](#))
- k. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the major BM: Applied Music – Piano BMAS** (0066)([attachment](#))
- l. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)

**for the request to revise the major BM: Applied Music – Voice BMAS**  
(0067)([attachment](#))

- m.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise major Bachelor of Music BM: Music Theory** (0068a)  
([attachment](#))
- n.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise major BM: Music Education – Choral – General - Piano BMAS** (0069)([attachment](#))
- o.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise major BM: Music Education – Choral – General – Voice BMAS** (0070) ([attachment](#))
- p.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise English major with Professional Writing concentration** (0076) ([attachment](#))
- q.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to add a concentration to the BA – Domestic Violence Prevention and Services: Women’s Studies** (0084) ([attachment](#)) ([support letter](#))

- r. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a minor – BA Domestic Violence Prevention and Services: Women’s Studies (0085)** ([attachment](#)) ([support letter](#))
  
- s. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a new minor in Restaurant Management (0017)**([attachment](#)) ([revised attachment 2-23-11](#)) ([revised attachment 2-23-11](#))
  
- t. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Physics Major-BA (0080)** ([revised attachment 2-23-11](#)) ([revised attachment 2-23-11](#)) ([revised checklist 2-23-11](#)) ([support doc.CISCHEM](#)) ([revision of the programs doc.](#))
  
- u. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Physics Major-BS (0081)** ([attachment revised 2-23-11](#)) ([attachment revised 2-23-11](#)) ([revised checklist 2-23-11](#))
  
- v. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Physics/Astronomy Major – BS (0082)** ([attachment revised 2-23-11](#)) ([attachment revised 2-23-11](#)) ([revised checklist 2-23-11](#))
  
- w. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Physics Education Major – BA (0083)** ([revised attachment 2-23-11](#)) ([revised attachment 2-23-11](#)) ([revised checklist 2-23-11](#))

- x. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to clarify the fit of the Apparel Design program with Arts & Sciences breadth requirements** (0086) ([revised 3-10-11](#))
  
- y. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to clarify the fit of the Fashion Merchandising program with Arts & Sciences breadth requirements** (0087) ([revised 3-10-11](#)) ([attachment](#))
  
- z. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise minor in Fashion History and Culture** (0088) ([revised 3-10-11](#))
  
- aa. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) and Graduate Studies (Robert Opila, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add the Nurse Practitioner concentration to the RN to MSN** (0089) ([attachment policy manual](#)) ([revised 3-10-11](#))
  
- bb. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add new academic policy to the Associate in Arts program** (0073) ([revised 3-11-11](#))
  
- cc. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on



- Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise the BS in Psychology (0057)** ([attachment](#))
- dd.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise the BA major in Political Science and International Relations (0058)** ([attachment](#))
- ee.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise the BA major in Political Science Education (0059)** ([attachment](#))
- ff.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise the minor in Political Science – BA (0060)** ([attachment](#))
- gg.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to add a new minor in Public Policy (0061)** ([revised attachment 3-10-11](#)) ([attachment library support](#))
- hh.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair)  
**for the request to revise the BS major requirements in Mathematics BSAS (0052)** ([attachment](#)) ([support UNIV101attachment 2-11-11](#)) ([revised attachment 3-15-11](#))

- ii. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the BA major requirements in Mathematics BAAS** (0053) ([attachment](#)) ([revised attachment 3-15-11](#))
  
- jj. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the BS major requirements in Mathematics and Economics** (0054) ([attachment](#)) ([revised attachment 3-15-11](#))
  
- kk. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a minor in Energy and Environmental Policy** (0097) ([attachment](#))
  
- ll. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise minor concentration in Spanish Studies** (0096) ([attachment](#))
  
- mm. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the Major in Public Policy** (0098) ([attachment](#))
  
- nn. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Exercise Science Major and Concentration Medical Scholar** (0024) ([support from Physics](#)) ([revised attachment 3-24-11](#))

- oo.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Exercise Science Major and Concentration Exercise Science Exercise Physiology** (0025) ([revised attachment 3-25-11](#))
- pp.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Exercise Science Major and Concentration Exercise Science Biomechanics & Motor Control** (0026) ([attachment 3-24-11](#))
- qq.** Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise Athletic Training Major** (0027) ([attachment](#)) ([revised attachment 3-24-11](#))
- rr.** Recommendation from the Faculty Senate Committee on Graduate Studies (Robert Opila, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to revise the graduate program in Political Science and International Relations MA PhD** ([attachment](#))

## **VI. Regular Agenda**

### **a. Resolutions**

1. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a new Major in Hospitality**

**Industry Studies** (0019) ([revised attachment 3-1-11 catalog](#)) ([revised attachment 3-1-11 library support](#)) ([revised attachment 3-1-11 curriculum requirements](#)) ([revised attachment 3-1-11 curriculum outline](#)) ([revised attachment 3-1-11 gen ed goals](#)) ([revised attachment 3-1-11 how it's different](#)) ([attachment 3-1-11 potential for double major](#)) ([attachment revised form 3-1-11](#)) ([resolution doc 3-1-11](#)) ([attachment 3-1-11 area of focus](#))

WHEREAS, the Department of Hotel, Restaurant and Institutional Management (HRIM) in the Lerner College of Business and Economics has offered a successful program for the BS in HRIM offering students skills for successfully operating a hospitality business, and

WHEREAS, HRIM has received many inquiries over the last several years from individuals who are interested in pursuing careers in the hospitality industry, but not in the operations area, and

WHEREAS, HRIM has proposed Hospitality Industry Studies major, which will offer an alternate route for students to pursue careers with specialized skills in the support areas of the hospitality industry, such as Sales & Marketing Management, Internet Marketing, Information Systems, Transactional Advisory Services, Revenue Management, etc., and

WHEREAS, the existing undergraduate program in Hotel, Restaurant and Institutional Management already provides a majority of all the courses and administrative framework for such a degree, and

WHEREAS, the proposed major contributes to one of the milestones on the University's "path to prominence" to achieve excellence in professional education; be it therefore

RESOLVED, that the Faculty Senate recommends provisionally for five years the approval of the establishment of a new Bachelor of Science in Hospitality Industry Studies.

2. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to change the name of the current East Asian Studies program/major to Asian Studies and to revise the program** (0074) ([attachment 3-1-11](#)) ([support ANTH](#)) ([support ENG](#)) ([support email Pika](#)) ([side by side attachment](#)) ([resolution attachment](#))

WHEREAS, the East Asian Studies program and faculty have expressed the intent to rename its program and major to Asian Studies and

WHEREAS, the newly renamed Asian Studies major will continue to be interdisciplinary, drawing from various departments (including but not limited to History, Foreign Languages & Literatures, Anthropology, Political Science, Art History, Philosophy, Art) ; and

WHEREAS, the renamed Asian Studies major will continue to support the 10 goals of undergraduate education and the academic priorities of the University's stated goal to promote programs which engage in interdisciplinary teaching and research; and

WHEREAS, the renamed Asian Studies major and program has broad support from faculty across contributing departments and the College of Arts and Sciences; be it therefore

RESOLVED, that the Faculty Senate approves the revisions and the name change to the major entitled Baccalaureate of Arts in Asian Studies, effective May 1, 2011.

3. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to change the program name and revise the program – East Asian Studies Honors (0074a) ([attachment 3-1-11](#))**

WHEREAS, the East Asian Studies Honors program and faculty have expressed the intent to rename its honors program and major to Asian Studies Honors and

WHEREAS, the newly renamed Asian Studies Honors major will continue to be interdisciplinary, drawing from various departments (including but not limited to History, Foreign Languages & Literatures, Anthropology, Political Science, Art History, Philosophy, Art) ; and

WHEREAS, the renamed Asian Studies Honors major will continue to support the 10 goals of undergraduate education and the academic priorities of the University's stated goal to promote programs which engage in interdisciplinary teaching and research; and

WHEREAS, the renamed Asian Studies Honors major and program has broad support from faculty across contributing departments and the College of Arts and Sciences; be it therefore

RESOLVED, that the Faculty Senate approves the revisions and the name change to the major entitled Baccalaureate of Arts in Asian Studies Honors, effective May 1, 2011.

4. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a new BA in Linguistics** (0055a) ([attachment](#)) ([attachment](#)) ([attachment](#)) (resolution revised [attachment](#)) ([revised 3-1-11](#)) ([revised 3-1-11](#))

WHEREAS, language is one of mankind's most complicated and important abilities and its understanding is one of the major goals of science and the humanities, and

WHEREAS, language is implicated in everything else that humans engage in, and so Linguistics interfaces with just about every discipline of study at the University, and

WHEREAS, language being so central to human cognition, Linguistics has been one of the cornerstones of the interdisciplinary study of Cognitive Science since its emergence over the last 50–60 years, and

WHEREAS, undergraduate interest and enrollment in Linguistics has been increasing nationally, and

WHEREAS, students with a BA in Linguistics can go on to numerous fields of graduate study, including applied fields that will benefit the community, and

WHEREAS, the proposed major is similar to Linguistics programs at other major universities in the country, and

WHEREAS, the proposed major would fill the gap left by the PhD in Linguistics, the MA in Linguistics and Cognitive Science, and the Minor in Linguistics, and

WHEREAS, all the resources for the major already exist to serve the PhD in Linguistics, MA in Linguistics and Cognitive Science, BS in Cognitive Science, and Minor in Linguistics, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for five years, the establishment of a new major leading to the B.A. degree in Linguistics, effective September 1, 2011.

5. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a new Honors BA in Linguistics** (0055b) ([attachment](#)) ([attachment](#))

WHEREAS, the BA in Linguistics is being proposed to be implemented in Fall 2011, and

WHEREAS, an Honors degree option would enhance the degree program and provide the option for Honors program students, and

WHEREAS, the Honors BA degree in Linguistics will provide Honors program students with a solid academic foundation and a pathway for success for entrance into graduate programs or careers in the field, and



WHEREAS, the Department of Linguistics and Cognitive Science includes an internationally renowned Linguistics program taught by faculty that are leaders in the field, the Undergraduate Major capitalizes on this valuable resource and provides undergraduate students with an intellectually rigorous experience enabling them to emerge as the next generation of leaders, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for five years, the establishment of a new major leading to the Honors B.A. degree in Linguistics, effective September 1, 2011.

6. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to move the English Language Institute into the College of Arts and Sciences (0091)** ([attachment](#)) ([attachment](#))

WHEREAS, the English Language Institute's mission of teaching, research, and service in second language acquisition, cross-cultural communication, and academic preparation aligns with that of many departments within the College of Arts and Sciences, and

WHEREAS, the English Language Institute is an academic unit requiring a college home, and

WHEREAS, the faculty members of the English Language Institute endorse the transfer of the unit to the College of Arts and Sciences, and

WHEREAS, the proposal for the transfer of the English Language Institute from the College of Education and Human Development to the College of Arts and Sciences is acceptable to the Deans of each College

and has been approved unanimously by the CAS Faculty Senate,  
be it therefore

RESOLVED, that the University Faculty Senate affirms the proposed transfer of the English Language Institute from the College of Education and Human Development to the College of Arts and Sciences.

7. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) and Graduate Studies (Robert Opila, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a 4 + 1 option in Neuroscience in the Department of Psychology** (0099) ([attachment revised 3-10-11](#)) ([resolution 3-22-11](#))

WHEREAS, the proposed 4+1 BS/MS Degree Program in Neuroscience offers an alternate route for qualified students at the University of Delaware to pursue a Master's Degree in Neuroscience, and

WHEREAS, several peer universities have begun to offer similar five year accelerated Master's Degree Programs in Neuroscience, and

WHEREAS, the existing undergraduate and graduate programs in Neuroscience already provide all the courses, laboratory facilities, and administrative framework for such a degree, and

WHEREAS, the proposed program contributes to two milestones on the University's "path to prominence" to: a) become a premier research and graduate university, and b) to achieve excellence in professional education, be it therefore

RESOLVED, that the Faculty Senate recommends approval of the

establishment of a new 4+1 Master of Science Degree Program in Neuroscience to the concurrent awarding of the Bachelor of Science Degree after the equivalent of 5 years full-time study as proposed.

8. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) and Graduate Studies (Robert Opila, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to create a 4 + 1 in BS/MS Mathematical Sciences** (0062) ([attachment](#)) ([revised attachment 3-22-11](#))

WHEREAS, the proposed 4 + 1 Bachelor of Science in Mathematics and Master of Science in Mathematics offers an alternate accelerated route for highly qualified students to begin pursuing a master's degree while an undergraduate mathematics major at the University of Delaware, and

WHEREAS, multiple students have expressed an interest in this program or have followed such a program in an ad-hoc manner, and

WHEREAS, the existing graduate program in Mathematics already provide all the courses and administrative framework for such a degree, and

WHEREAS, the proposed program contributes to two milestones on the University's "Path to Prominence" to become a premier research and graduate university; to achieve excellence in professional education; be it therefore

RESOLVED, that the Faculty Senate recommends approval of the establishment of a new 4+1 Bachelor of Science in Mathematics and Master of Science in Mathematics in the Department of Mathematical Sciences.

9. Recommendation from the Faculty Senate Committee on Graduate Studies (Robert Opila, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request of a new Doctor of Philosophy Degree in Water Science and Policy** ([attachment](#))

WHEREAS, the proposed *Doctor of Philosophy in Water Science and Policy* provides a new interdisciplinary graduate course of study in a critical area of 21<sup>st</sup> century environmental science, engineering and policy and is key to our understanding of complex local, regional and national water challenges, impacting the science and technology of fields ranging from agricultural, energy and environmental sciences to social sciences and law, and

WHEREAS, the proposed *Doctor of Philosophy in Water Science and Policy* will allow students with strong environmental science, engineering or policy backgrounds to develop depth and breadth of expertise in understanding water-related challenges through research and experience in developing solutions through the study of biological, chemical, geological, social and economic systems, and

WHEREAS, the proposed program builds upon the research strength, education resources and research infrastructure from Departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Engineering, Earth, Ocean and Environment, as well as from the Delaware Environmental Institute, and

WHEREAS, the proposed program contributes to the scholarly and educational missions of the University—to disseminate scientific, humanistic, and social knowledge for the benefit of the larger society and to produce graduates who are prepared to contribute to a global society, addressing the critical needs of the state, nation and global community, and

WHEREAS, the proposed program fosters multi- and interdisciplinary research and educational collaboration across campus, providing a critical component to University's strategic priorities in energy, environment, and life and health sciences, and serving as a pillar of UD's *Path to Prominence*, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for seven years, the establishment of a new program leading to the *Doctor of Philosophy in Water Science and Policy* effective September 1, 2011.

10. Recommendation from the Faculty Senate Committee on Graduate Studies (Robert Opila, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request of a new Master of Science Degree in Water Science and Policy** ([attachment](#))

WHEREAS, the proposed *Master of Science in Water Science and Policy* provides a new interdisciplinary graduate course of study in a critical area of 21<sup>st</sup> century environmental science, engineering and policy and is key to our understanding of complex local, regional and national water challenges, impacting the science and technology of fields ranging from agricultural, energy and environmental sciences to social sciences and law, and

WHEREAS, the proposed *Master of Science in Water Science and Policy* will allow students with strong environmental science, engineering or policy backgrounds to develop depth and breadth of expertise in understanding water-related challenges through research and experience in developing solutions through the study of biological, chemical, geological, social and economic systems, and

WHEREAS, the proposed program builds upon the research strength, education resources and research infrastructure from Departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean and Environment, and Engineering, as well as from the Delaware Environmental Institute, and

WHEREAS, the proposed program contributes to the scholarly and educational missions of the University—to disseminate scientific, humanistic, and social knowledge for the benefit of the larger society and to produce graduates who are prepared to contribute to a global society, addressing the critical needs of the state, nation and global community, and

WHEREAS, the proposed program fosters multi- and interdisciplinary research and educational collaboration across campus, providing a critical component to University's strategic priorities in energy, environment, and life and health sciences, and serving as a pillar of UD's *Path to Prominence*, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for five years, the establishment of a new program leading to the *Master of Science in Water Science and Policy* effective September 1, 2011.

11. Recommendation from the Faculty Senate Committee on Undergraduate Studies (Fred Hofstetter, Chair) with the concurrence of the Coordinating Committee on Education (Jeff Jordan, Chair) and the Executive Committee (John Madsen, Chair) **for the request to add a major Bachelor of Music BM: Music History & Literature (0068b) ([attachment](#))**

WHEREAS, the Department Music has expressed the intent to create a major in Music History and Literature within the Bachelor of Music, and

WHEREAS, the Department of Music has a growing number of students who have expressed an interest in the study of Music History and Literature, and

WHEREAS, these students will be best served by a rigorous academic degree that prepares them for graduate study in Musicology, and

WHEREAS, the study of Music History and Literature adds an important element of interdisciplinary study in the area of music, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for five years, the new major entitled Music History and Literature within the degree Bachelor of Music, effective September 1, 2011.

a. **Unfinished Business:** None

b. **New Business:** None

## **VII. Introduction of New Business**

Such items as may come before the Senate. (No motion introduced under new business, except a motion to refer to committee, shall be acted upon until the next meeting of the Senate.)

**C. Copy of the original program proposal that was submitted for provisional status.**





**UNIVERSITY OF DELAWARE**

# **GRADUATE PROGRAMS IN WATER SCIENCE & POLICY**

## **ACADEMIC PROGRAM APPLICATION**

**March 2011**

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## EXECUTIVE SUMMARY

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are threatening the quantity and quality of water resources worldwide. Addressing these challenges require solutions that are not only scientifically sound but are socially acceptable, economically viable, and environmentally sustainable. The new program in Water Science and Policy will train students to think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

The Water Science and Policy Program will: (a) capitalize on existing strengths and add coherence to the existing body of water science and water policy experts; (b) provide a valuable tool to enhance graduate student recruitment; (c) help attract and retain strong faculty; (d) provide opportunities for interactions among researchers from diverse disciplines; and (e) serve as a springboard/catalyst for large-scale educational funding opportunities such as the Integrative Graduate Education and Research Traineeship (IGERT).

The graduate program in Water Science and Policy will provide three degree options: 1) a PhD, with a water science concentration (36 credits total); 2) a PhD, with a water policy concentration (36 credits); and 3) a Master of Science, with thesis (30 credits).

The program will be administrated by a Faculty Director in close coordination with the Program Committee. Faculty affiliated with the program will be able to recruit and advise students and help shape the future direction of the program. The Program Committee and the affiliated faculty include representatives from the Colleges of Agriculture and Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering.

Students will be able to apply to the university-wide graduate program directly through a link provided on the university Graduate Admissions homepage. The students will be required to meet the specific qualifications of the program to be admitted and awarded the degree in Water Science & Policy. The program students will be housed in the Colleges associated with their primary advisor and the degree will be awarded by the College of residence.

The graduate program in Water Science & Policy is synergistic with other programs on campus, and draws almost entirely upon existing courses. The academic deans and chairs of Colleges and Departments involved have provided enthusiastic support to the program.

The graduate program in Water Science and Policy is well aligned with the strategic priorities at the University including an emphasis on environmental research and the University's Initiative for the Planet, all within the University's Path to Prominence.

## **PART I**

### **UNIVERSITY FACULTY SENATE FORMS**

# DOCTOR OF PHILOSOPHY IN WATER SCIENCE & POLICY

## Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. For more information, call the Faculty Senate Office at 831-2921.

**Submitted by:** Shreeram P. Inamdar      phone number 831- 8877.

**Department:** Bioresources Engineering      email address: inamdar@UDel.Edu

**Action:** Request for New Doctor of Philosophy Degree in Water Science & Policy.

(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc.)

**Effective term** 11F  
(use format 04F, 05W)

**Current degree** N/A  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed change leads to the degree of:** PhD  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed name:** Doctor of Philosophy in Water Science & Policy  
Proposed new name for revised or new major / minor / concentration / academic unit  
(If applicable)

## Revising or Deleting:

**Undergraduate major / Concentration:** N/A  
(Example: Applied Music – Instrumental degree BMAS)

**Undergraduate minor:** N/A  
(Example: African Studies, Business Administration, English, Leadership, etc.)

**Graduate Program Policy statement change:** N/A  
(**Must attach** your Graduate Program Policy Statement)

**Graduate Program of Study:** PhD Water Science and Policy  
(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

**Graduate minor /concentration:** Water Science Concentration, Water Policy Concentration

**Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, highlighting the changes made to the original policy document.**

**List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?**

(Be aware that approval of the curriculum is dependent upon these courses successfully passing through the Course Challenge list. If there are no new courses enter “None”)

None

**Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education:** <http://www.ugs.udel.edu/gened/>

N/A

**Identify other units affected by the proposed changes:**

(Attach permission from the affected units. If no other unit is affected, enter “None”)

College of Agriculture & Natural Resources  
Department of Bioresources Engineering  
Department of Plant & Soil Sciences  
Department of Food & Resource Economics  
College of Arts & Sciences:  
Department of Chemistry & Biochemistry  
School of Public Policy & Administration  
Department of Political Science & International Relations  
College of Earth, Ocean & Environment  
Department of Geography  
Department of Geological Sciences  
School of Marine Science and Policy  
College of Engineering  
Center for Energy and Environmental Policy  
Department of Civil & Environmental Engineering  
Department of Chemical Engineering  
Department of Mechanical Engineering

**Describe the rationale for the proposed program change(s):**

(Explain your reasons for creating, revising, or deleting the curriculum or program.)

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are putting immense pressure on the supply and quality of our water resources. Addressing these complex challenges and finding solutions will require a comprehensive, integrated and interdisciplinary approach. Not only do we have to address the physical, chemical and biological aspects of these problems but also make sure that the proposed solutions are socially acceptable, economically viable, and environmentally sustainable. The National Science Foundation, National Academy of Sciences, Congressional Research Service, USGS, NOAA, and USEPA have all concluded that a new interdisciplinary education and research approach is needed that integrates science and policy to address society's emerging challenges in water sustainability. An interdisciplinary graduate program in Water Science and Policy at the University of Delaware would address this challenge by training students and professionals who can think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

While there are many experts in the fields of water sciences and policy at the University of Delaware they are dispersed throughout several Colleges and Departments on campus. There is no coordinated body or program that unifies this group and provides a means to maximize collaborative research and education. An interdisciplinary Water Science and Policy Program would: (a) capitalize on existing strengths of the University and add coherence to the existing body of water science and water policy experts; (b) provide a valuable tool to enhance graduate student recruitment; (c) help attract and retain strong faculty; (d) provide opportunities for interactions among researchers from diverse disciplines; and (e) serve as a springboard/catalyst for large-scale educational funding opportunities such as the Integrative Graduate Education and Research Traineeship (IGERT).

A graduate program in Water Science and Policy is well aligned with the strategic priorities at the University, including an emphasis on environmental research, the plans underway to hire six to eight environmentally focused faculty, and the University's *Initiative for the Planet*, all within the University's *Path to Prominence*.

**Table 1. PhD Program Requirements: Water Science & Policy**

PhD in Water Science & Policy (36 Credits)		
Course Areas	Water Science Concentration	Water Policy Concentration
Water Science	9 Credits	3 Credits
Water Policy	3 Credits	9 Credits
Research Methods	3 Credits	3 Credits
Statistics, Analysis & Techniques	3 Credits	3 Credits
Directed Rsch/Special Prob./Internship/Independent Study	9 Credits	9 Credits
Dissertation	9 Credits	9 Credits
<div><div>Science Courses</div><div><div>Water Science Concentr. Students (9)</div><div>[Select at least 3 credits from each category.]</div></div><div><div>Water Policy Concentr. Students (3)</div><div>[Select one course from physical or chemical/biological science.)</div></div></div>	<b>a) Physical Sciences</b>	
	BREG 623 Advanced Storm water Management	
	CIEG 698 Groundwater Flow and Contaminant Transport	
	GEOG 632 Environmental Hydrology	
	GEOG 656 Hydroclimatology	
	GEOG 651 Microclimatology (4)	
	GEOL 628 Hydrogeology	
	GEOL 611 Fluvial Geomorphology	
	PLSC 603 Soil Physics	
	<b>b) Chemical/Biological Sciences</b>	
	BREG 621 Nonpoint source pollution	
	BREG 667 Watershed Hydrochemistry	
	CHEM/MAST 683 Environmental Chemistry	
	CIEG 632 Chemical Aspects of Environmental Engineering	
	CIEG 636 Biological aspects of Environmental Engineering	
	CIEG 668 Principles of Water Quality Criteria	
	GEOG 631 Watershed Ecology	
	GEOG 667 Watershed Hydro-Ecology	
	PLSC 608/CHEM 608 Environmental Soil Chemistry	
	<b>c) Policy</b>	
	ENEP 626 Climate Change: Science, Policy and Political Economy	
	ENEP 666 Topics in Sustainable Development	
	ENEP 810 Political Economy of the Environment	
ENEP 868 Sustainable Water Policy Research		
ENEP 870 Sustainable Water Policy Readings		
GEOG 617 Seminar in Climate Change		
GEOG 649 Environment & Society		
<b>Water Science Concentr. Students (3)</b> [Select one course.]		
MAST 672/ECON 670 Applied Policy Analysis		
MAST/ECON 867 Valuing the Environment		
MAST 670 US Ocean and Coastal Policy		
<b>Water Policy Concentr. Students (9)</b> [Select three courses.]		
MAST/ECON 676 Environmental Economics		
MAST/UAPP 663 Decision Tools for Policy Analysis		
POSC 818 Environmental Politics and Policy		
UAPP 611 Regional Watershed Management		
UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)		
UAPP 628 Issues in Land Use and Environmental Planning		
UAPP 667 Field Seminar in Water Policy		
<b>Research Methods Courses (3)</b>		
<b>d) Research Methods</b>		
PLSC 667 Research Methods and Topics in Water Science & Policy (2)		
PLSC 667 Interdisciplinary Seminar (1)		
<b>e) Statistics, Analysis &amp; Techniques:</b>		
CHEG 604 Probability and Statistics for Engineering Problem Solving		
FREC/STAT 608 Statistical Research Methods		
FREC 615 Advanced Prices and Statistics		
FREC/STAT 674 Applied Database Management		
FREC 807 Mathematical Programming with Economic Applications		
GEOG 671 Advanced Geographic Information Systems		
MAST 681 Remote Sensing of Environment		
MEEG 690 Intermediate Engineering Mathematics		
STAT 657 Statistics for Earth Sciences		
STAT 675 Logistic Regression		
UAPP 816 Advanced Social Statistics		
UAPP 691 Quantitative Analysis in Public & NP Sectors		
UAPP 652 Geographic Information Systems in Public Policy (1)		
Directed Research/Special Problem/Internship/Independent Study (9)		
Dissertation (9)		



## ROUTING AND AUTHORIZATION

(Please do not remove supporting documentation.)

Department Chairperson \_\_\_\_\_ Date \_\_\_\_\_

Dean of College \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, College Curriculum Committee \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Com. on UG or GR Studies \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Coordinating Com. \_\_\_\_\_ Date \_\_\_\_\_

Secretary, Faculty Senate \_\_\_\_\_ Date \_\_\_\_\_

Date of Senate Resolution \_\_\_\_\_ Date to be Effective \_\_\_\_\_

Registrar \_\_\_\_\_ Program Code \_\_\_\_\_ Date \_\_\_\_\_

Vice Provost for Academic Affairs & International Programs \_\_\_\_\_ Date \_\_\_\_\_

Provost \_\_\_\_\_ Date \_\_\_\_\_

Board of Trustee Notification \_\_\_\_\_ Date \_\_\_\_\_

# MASTER OF SCIENCE IN WATER SCIENCE & POLICY

## Academic Program Approval

This form is a routing document for the approval of new and revised academic programs. Proposing department should complete this form. For more information, call the Faculty Senate Office at 831-2921.

**Submitted by:** Shreeram P. Inamdar      phone number 831- 8877.

**Department:** Bioresources Engineering      email address: inamdar@UDel.Edu

**Action:** Request for New Master of Science Degree in Water Science & Policy.

(Example: add major/minor/concentration, delete major/minor/concentration, revise major/minor/concentration, academic unit name change, request for permanent status, policy change, etc.)

**Effective term** 11F  
(Use format 04F, 05W)

**Current degree** N/A  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed change leads to the degree of:** MS  
(Example: BA, BACH, BACJ, HBA, EDD, MA, MBA, etc.)

**Proposed name:** Master of Science in Water Science & Policy  
Proposed new name for revised or new major / minor / concentration / academic unit  
(If applicable)

### Revising or Deleting:

**Undergraduate major / Concentration:** N/A  
(Example: Applied Music – Instrumental degree BMAS)

**Undergraduate minor:** N/A  
(Example: African Studies, Business Administration, English, Leadership, etc.)

**Graduate Program Policy statement change:** N/A  
(**Must attach** your Graduate Program Policy Statement)

**Graduate Program of Study:** MS Water Science and Policy  
(Example: Animal Science: MS Animal Science: PHD Economics: MA Economics: PHD)

**Graduate minor /concentration:** n/a

**Note: all graduate studies proposals must include an electronic copy of the Graduate Program Policy Document, highlighting the changes made to the original policy document.**

**List new courses required for the new or revised curriculum. How do they support the overall program objectives of the major/minor/concentrations)?**

(Be aware that approval of the curriculum is dependent upon these courses successfully passing through the Course Challenge list. If there are no new courses enter “None”)

None

**Explain, when appropriate, how this new/revised curriculum supports the 10 goals of undergraduate education:** <http://www.ugs.udel.edu/gened/>

N/A

**Identify other units affected by the proposed changes:**

(Attach permission from the affected units. If no other unit is affected, enter “None”)

College of Agriculture & Natural Resources  
Department of Bioresources Engineering  
Department of Plant & Soil Sciences  
Department of Food & Resource Economics  
College of Arts & Sciences:  
Department of Chemistry & Biochemistry  
School of Public Policy & Administration  
Department of Political Science & International Relations  
College of Earth, Ocean & Environment  
Department of Geography  
Department of Geological Sciences  
School of Marine Science and Policy  
College of Engineering  
Center for Energy and Environmental Policy  
Department of Chemical Engineering  
Department of Civil & Environmental Engineering  
Department of Mechanical Engineering

**Describe the rationale for the proposed program change(s):**

(Explain your reasons for creating, revising, or deleting the curriculum or program.)

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are putting immense pressure on the supply and quality of our water resources. Addressing these complex challenges and finding solutions will require a comprehensive, integrated and interdisciplinary approach. Not only do we have to address the physical, chemical and biological aspects of these problems but also make sure that the proposed solutions are socially acceptable, economically viable, and environmentally sustainable. The National Science Foundation, National Academy of Sciences, Congressional Research Service, USGS, NOAA, and USEPA have all concluded that a new interdisciplinary education and research approach is needed that integrates science and policy to address society's emerging challenges in water sustainability. An interdisciplinary graduate program in Water Science and Policy at the University of Delaware would address this challenge by training students and professionals who can think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

While there are many experts in the fields of water sciences and policy at the University of Delaware they are dispersed throughout several Colleges and Departments on campus. There is no coordinated body or program that unifies this group and provides a means to maximize collaborative research and education. An interdisciplinary Water Science and Policy Program would: (a) capitalize on existing strengths of the University and add coherence to the existing body of water science and water policy experts; (b) provide a valuable tool to enhance graduate student recruitment; (c) help attract and retain strong faculty; (d) provide opportunities for interactions among researchers from diverse disciplines; and (e) serve as a springboard/catalyst for large-scale educational funding opportunities.

A graduate program in Water Science and Policy is well aligned with the strategic priorities at the University, including an emphasis on environmental research, the plans underway to hire six to eight environmentally focused faculty, and the University's *Initiative for the Planet*, all within the University's *Path to Prominence*.

**Table 2. Master of Science Program Requirements: Water Science & Policy**

<b>MS in Water Science &amp; Policy (30 Credits)</b>	
Credit Hours Total	
Water Science, Policy, Statistics & Analysis	24 Credits
Thesis	6 Credits
<b>MS in Water Science &amp; Policy – Course Curriculum</b>	
<b>Select 24 credits, with at least 3 credits from each category.</b>	<b>a) Physical Sciences</b>
	BREG 623 Advanced Storm water Management
	CIEG 698 Groundwater Flow and Contaminant Transport
	GEOG 632 Environmental Hydrology
	GEOG 656 Hydroclimatology
	GEOG 651 Microclimatology (4)
	GEOL 628 Hydrogeology
	GEOL 611 Fluvial Geomorphology
	PLSC 603 Soil Physics
	<b>b) Chemical/Biological Sciences</b>
	BREG 621 Nonpoint source pollution
	BREG 667 Watershed Hydrochemistry
	CHEM/MAST 683 Environmental Chemistry
	CIEG 632 Chemical Aspects of Environmental Engineering
	CIEG 636: Biological aspects of environmental engineering
	CIEG 668 Principles of Water Quality Criteria
	GEOG 631 Watershed Ecology
	GEOG 667 Watershed Hydro-Ecology
	PLSC 608/CHEM 608 Environmental Soil Chemistry
	<b>c) Policy</b>
	ENEP 626 Climate Change: Science, Policy and Political Economy
	ENEP 666 Topics in Sustainable Development
	ENEP 810 Political Economy of the Environment
	ENEP 868 Sustainable Water Policy Research
	ENEP 870 Sustainable Water Policy Readings
	GEOG 617 – Seminar in Climate Change
	GEOG 649 – Environment & Society
	MAST 672/ECON 670 Applied Policy Analysis
	MAST/ECON 867 Valuing the Environment
	MAST 670 US Ocean and Coastal Policy
	MAST/ECON 676 Environmental Economics
	MAST/UAPP 663 Decision Tools for Policy Analysis
	POSC 818 Environmental Politics and Policy
	UAPP 611 Regional Watershed Management
	UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)
	UAPP 628 Issues in Land Use and Environmental Planning
	UAPP 667 Field Seminar in Water Policy
	<b>d) Research Methods in Water Science &amp; Policy</b>
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)
	PLSC 667 Interdisciplinary Seminar (1)
	<b>e) Statistics &amp; Analysis:</b>
	CHEG 604 Probability and Statistics for Engineering Problem Solving
	FREC/STAT 608 Statistical Research Methods
	FREC 615 Advanced Prices and Statistics
	FREC/STAT 674 Applied Database Management
	FREC 807 Mathematical Programming with Economic Applications
	GEOG 671 Advanced Geographic Information Systems
	MAST 681 – Remote Sensing of Environment
	MEEG 690 Intermediate Engineering Mathematics
	STAT 657 Statistics for Earth Sciences
	STAT 675 Logistic Regression
	UAPP 816 Advanced Social Statistics
	UAPP 691 Quantitative Analysis in Public & NP Sectors
	UAPP 652 Geographic Information Systems in Public Policy (1)
<b>Directed Research Option (3)</b> With advisor approval, MS students may opt to carry out directed research, in lieu of one course, within categories a, b, or c above.	
<b>Thesis (6)</b>	

## ROUTING AND AUTHORIZATION

(Please do not remove supporting documentation.)

Department Chairperson \_\_\_\_\_ Date \_\_\_\_\_

Dean of College \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, College Curriculum Committee \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Com. on UG or GR Studies \_\_\_\_\_ Date \_\_\_\_\_

Chairperson, Senate Coordinating Com. \_\_\_\_\_ Date \_\_\_\_\_

Secretary, Faculty Senate \_\_\_\_\_ Date \_\_\_\_\_

Date of Senate Resolution \_\_\_\_\_ Date to be Effective \_\_\_\_\_

Registrar \_\_\_\_\_ Program Code \_\_\_\_\_ Date \_\_\_\_\_

Vice Provost for Academic Affairs & International Programs \_\_\_\_\_ Date \_\_\_\_\_

Provost \_\_\_\_\_ Date \_\_\_\_\_

Board of Trustee Notification \_\_\_\_\_ Date \_\_\_\_\_

## **PART II**

### **RESOLUTION STATEMENTS**

# PROVISIONAL APPROVAL OF NEW PROGRAMS -- RESOLUTION

## DOCTOR OF PHILOSOPHY IN WATER SCIENCE AND POLICY

WHEREAS, the proposed *Doctor of Philosophy in Water Science and Policy* provides a new interdisciplinary graduate course of study in a critical area of 21<sup>st</sup> century environmental science, engineering and policy and is key to our understanding of complex local, regional and national water challenges, impacting the science and technology of fields ranging from agricultural, energy and environmental sciences to social sciences and law, and

WHEREAS, the proposed *Doctor of Philosophy in Water Science and Policy* will allow students with strong environmental science, engineering or policy backgrounds to develop depth and breadth of expertise in understanding water-related challenges through research and experience in developing solutions through the study of biological, chemical, geological, social and economic systems, and

WHEREAS, the proposed program builds upon the research strength, education resources and research infrastructure from Departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Engineering, Earth, Ocean and Environment, as well as from the Delaware Environmental Institute, and

WHEREAS, the proposed program contributes to the scholarly and educational missions of the University—to disseminate scientific, humanistic, and social knowledge for the benefit of the larger society and to produce graduates who are prepared to contribute to a global society, addressing the critical needs of the state, nation and global community, and

WHEREAS, the proposed program fosters multi- and interdisciplinary research and educational collaboration across campus, providing a critical component to University's strategic priorities in energy, environment, and life and health sciences, and serving as a pillar of UD's *Path to Prominence*, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for seven years, the establishment of a new program leading to the *Doctor of Philosophy in Water Science and Policy* effective September 1, 2011.

# PROVISIONAL APPROVAL OF NEW PROGRAMS -- RESOLUTION

## MASTER OF SCIENCE IN WATER SCIENCE AND POLICY

WHEREAS, the proposed *Master of Science in Water Science and Policy* provides a new interdisciplinary graduate course of study in a critical area of 21<sup>st</sup> century environmental science, engineering and policy and is key to our understanding of complex local, regional and national water challenges, impacting the science and technology of fields ranging from agricultural, energy and environmental sciences to social sciences and law, and

WHEREAS, the proposed *Master of Science in Water Science and Policy* will allow students with strong environmental science, engineering or policy backgrounds to develop depth and breadth of expertise in understanding water-related challenges through research and experience in developing solutions through the study of biological, chemical, geological, social and economic systems, and

WHEREAS, the proposed program builds upon the research strength, education resources and research infrastructure from Departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean and Environment, and Engineering, as well as from the Delaware Environmental Institute, and

WHEREAS, the proposed program contributes to the scholarly and educational missions of the University—to disseminate scientific, humanistic, and social knowledge for the benefit of the larger society and to produce graduates who are prepared to contribute to a global society, addressing the critical needs of the state, nation and global community, and

WHEREAS, the proposed program fosters multi- and interdisciplinary research and educational collaboration across campus, providing a critical component to University's strategic priorities in energy, environment, and life and health sciences, and serving as a pillar of UD's *Path to Prominence*, be it therefore

RESOLVED, that the Faculty Senate approves provisionally, for five years, the establishment of a new program leading to the *Master of Science in Water Science and Policy* effective September 1, 2011.



## **PART III**

### **PROGRAM POLICY STATEMENT**

## I. PROGRAM HISTORY

### A. RATIONALE

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are putting immense pressure on the supply and quality of our water resources. Addressing these complex challenges and finding solutions will require a comprehensive, integrated and interdisciplinary approach. Not only must society address the physical, chemical and biological aspects of these problems; society must also ensure that the proposed solutions are socially acceptable, economically viable, and environmentally sustainable. The National Science Foundation, National Academy of Sciences, Congressional Research Service, USGS, NOAA, and USEPA have all concluded that a new interdisciplinary education and research approach is needed that integrates science and policy to address society's emerging challenges in water sustainability. The interdisciplinary graduate program in Water Science and Policy at the University of Delaware is focused on these challenges by training students and professionals who can think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

The graduate program in Water Science and Policy reflects the strategic priorities at the University of Delaware, including an emphasis on environmental research and sustainability, the growing number of environmentally focused faculty, and the University's *Initiative for the Planet*, all within the University's *Path to Prominence*.

The vision is a university-wide graduate program that will attract students to many departments and colleges across the campus. The students will be located within individual departments and will work with individual advisors who are affiliated with the program. The students are required to meet the specific requirements of the program to be awarded the degree in Water Science & Policy.

The graduate program in Water Science & Policy is synergistic with other programs on campus, and draws entirely upon existing courses. All students in the Water Science & Policy program take a team-taught course, entitled "Research Methods and Topics in Water Science and Policy" that involves both field and lab experiences, as well as a companion one-credit seminar series.

The academic deans and chairs of Colleges and Departments involved have provided their support to establish a cross-college program. Water Science & Policy will be administered in the College of Agriculture & Natural Resources; Dr. Shreeram Inamdar, Associate Professor of Bioresources Engineering is faculty program director.

The availability of high quality water to sustain human activities and ecosystem health is among the most critical global challenges of the 21<sup>st</sup> century, given pressures on water resources due to climate change, contaminants, population growth, hydropolitics, conservation issues and infrastructure challenges. Solutions to complex problems of water quantity and quality will require both scientific understanding and implementation through effective policy. Scientists, engineers and policy experts need to understand and predict the interactions of Earth's water system with climate change, land use, the built environment and ecosystem function and services. They will need to determine how the built water systems and our governance systems can be made more reliable, resilient and sustainable in the face of diverse and often conflicting needs.

Despite its name, the Earth is a water planet. However, pressure on water resources is growing, increasing the need for understanding water availability, quality and dynamics. The impacts of climate change and human activity have created an urgent need for experts who bring both depth and breadth of experience, and a systemic perspective to the science and policy of water at the local, regional, national, and international scales.

The program in Water Science and Policy at the University of Delaware is designed to meet this increasing national and international demand for interdisciplinary water experts and to provide students with an

educational opportunity that crosses traditional disciplinary and organizational boundaries. Due to the interdisciplinary nature of water sciences and policy, experts in these fields within the University of Delaware are housed in many Colleges and Departments and affiliated centers and institutes on campus; thus, the faculty affiliated with the program may be in one of several science, engineering or social science disciplines.

The Water Science & Policy program aims to train the next generation of researchers and professionals who will play key roles in protecting and managing a vital resource, and who will play a key role in multi- and interdisciplinary teams, bridging physical, chemical, biological and policy sciences. The program is administered through the College of Agriculture & Natural Resources, and the scientific curriculum builds upon the research and educational strengths of departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering. Water Science & Policy is an essential 21<sup>st</sup> century environmental thrust in academia, industry, and government, and affects public policy decisions across the globe.

## **B. DEGREES OFFERED**

Three degree options are offered: 1) the PhD in Water Science & Policy, Water Science Concentration; 2) the PhD in Water Science & Policy, Water Policy Concentration; and 3) the Master of Science in Water Science & Policy.

Doctoral students in the Water Science Concentration complete course requirements and carry out research that emphasizes science and engineering, but that provides exposure to policy tools and processes. Doctoral students in the Water Policy Concentration complete course requirements and carry out research that emphasizes economics and public policy, but that provides exposure to relevant science and engineering areas. Students in both Concentrations will have the opportunity to pursue directed research, a special problem, independent study or internship as part of required work.

The Master of Science option in Water Science and Policy prepares students to carry out advanced research at the doctoral level, or to take professional positions requiring graduate level preparation.

## **II. ADMISSION**

### **A. ADMISSION REQUIREMENTS**

Admission to graduate programs is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

To be admitted to the graduate program applicants should meet the following requirements:

1. A completed University of Delaware Graduate Studies application. In the application, prospective students should indicate clearly whether they are applying for the MS or the Ph.D. program (select the Water Science or the Water Policy concentration). Students may apply to the program prior to arranging for a faculty advisor; however, all students in the program will need the agreement of a program faculty member to serve as advisor for admission to the program.
2. A personal statement is required in the Graduate Studies application, and should discuss the following questions:
  - a. What are your specific research and educational goals?

- b. What are your long-term professional career objectives?
  - c. How do you see this program assisting you with achieving your objectives?
  - d. What is the name of the faculty member (affiliated with the program) who has agreed to be advisor?
3. Graduate Record Examination Scores are required (a minimum of 1050 on the VERBAL and QUANTITATIVE is desirable). Subject GRE scores are not required.
4. Official, up-to-date transcripts of all undergraduate and graduate programs. A minimum of 3.0/4.0 is required in the major.
5. Three letters of recommendation from individuals knowledgeable of the applicant's academic preparation and potential ability as a graduate student.
6. International students must take the Test of English as a Foreign Language (TOEFL) (Minimum Score: 550 paper test, 213 computer test or 79 on Internet-based tests.) TOEFL scores more than two years old cannot be considered official.

A graduate student applicant must, at the time of admission, have a faculty advisor who has agreed to direct and advise a program of study.

Applicants for the Ph.D. program will typically have an M.S. degree in a related field. Direct admission to the Ph.D. program immediately after a B.S. degree will only be considered for exceptionally qualified candidates, as determined by the Program Committee. These candidates will, however, have to complete all the course requirements associated with the Water Science and Policy M.S. program prior to starting the Ph.D. curriculum. Prior graduate coursework (a maximum of 9 credit hours) will be considered toward Ph.D. course requirements, with the approval of the Program Committee.

### **Change of Classification and Transfer Students**

Students that are currently matriculated in other degree programs should complete a “Change of Classification” Form to seek approval to be admitted into the Water Science and Policy Program. The Program Committee will evaluate the change in classification and transfer requests on a case-by case basis to determine if the applicant will need to complete a full application form submitted to the Office of Graduate and Professional Education. All transfer students will still have to meet the requirements listed above.

### **C. Application Deadlines**

Admission decisions are made on a rolling basis as and when applications are complete. The application deadlines are:

- Fall Semester: July 1<sup>st</sup> (regular application); March 1<sup>st</sup> (financial aid)
- Spring Semester: December 1<sup>st</sup> (regular application); October 1<sup>st</sup> (financial aid)

### III. ACADEMIC

#### A. DEGREE REQUIREMENTS

##### 1. COURSE REQUIREMENTS SUMMARY

###### a. PhD Program Requirements: Water Science & Policy

<b>PhD in Water Science &amp; Policy (36 Credits)</b>		
Course Areas	Water Science Concentration	Water Policy Concentration
Water Science	9 Credits	3 Credits
Water Policy	3 Credits	9 Credits
Research Methods	3 Credits	3 Credits
Statistics, Analysis & Techniques	3 Credits	3 Credits
Directed Research/Special Problem/Internship/Independent Study	9 Credits	9 Credits
Dissertation	9 Credits	9 Credits

###### b. Master of Science Program Requirements: Water Science & Policy

<b>MS in Water Science &amp; Policy (30 Credits)</b>	
Credit Hours Total	
Water Science, Policy, Research Methods, Statistics & Analysis	24 Credits
Thesis	6 Credits

##### 2. CURRICULUM

The tables below list the course curriculum for the major components of the graduate program in Water Science & Policy. Some courses may be offered at both the 400- and 600- levels. A student who has completed a course at the 400-level may not take the same course at the 600-level for credit toward the graduate degree.

**Table 1. PhD Program Requirements: Water Science & Policy**

PhD in Water Science & Policy (36 Credits)			
Course Areas	Water Science Concentration	Water Policy Concentration	
Water Science	9 Credits	3 Credits	
Water Policy	3 Credits	9 Credits	
Research Methods	3 Credits	3 Credits	
Statistics, Analysis & Techniques	3 Credits	3 Credits	
Directed Rsch/Special Prob./Internship/Independent Study	9 Credits	9 Credits	
Dissertation	9 Credits	9 Credits	
<div>Science Courses</div> <div>Water Science Concentr. Students (9) [Select at least 3 credits from each category.]</div> <div>Water Policy Concentr. Students (3) [Select one course from physical or chemical/biological science.]</div>	a) Physical Sciences		
	BREG 623 Advanced Storm water Management		
	CIEG 698 Groundwater Flow and Contaminant Transport		
	GEOG 632 Environmental Hydrology		
	GEOG 656 Hydroclimatology		
	GEOG 651 Microclimatology (4)		
	GEOL 628 Hydrogeology		
	GEOL 611 Fluvial Geomorphology		
	PLSC 603 Soil Physics		
	b) Chemical/Biological Sciences		
	BREG 621 Nonpoint source pollution		
	BREG 667 Watershed Hydrochemistry		
	CHEM/MAST 683 Environmental Chemistry		
	CIEG 632 Chemical Aspects of Environmental Engineering		
	CIEG 636 Biological aspects of Environmental Engineering		
	CIEG 668 Principles of Water Quality Criteria		
	GEOG 631 Watershed Ecology		
	GEOG 667 Watershed Hydro-Ecology		
	PLSC 608/CHEM 608 Environmental Soil Chemistry		
		c) Policy	
	<div>Policy Courses</div> <div>Water Science Concentr. Students (3) [Select one course.]</div> <div>Water Policy Concentr. Students (9) [Select three courses.]</div>	ENEP 626 Climate Change: Science, Policy and Political Economy	
		ENEP 666 Topics in Sustainable Development	
		ENEP 810 Political Economy of the Environment	
ENEP 868 Sustainable Water Policy Research			
ENEP 870 Sustainable Water Policy Readings			
GEOG 617 Seminar in Climate Change			
GEOG 649 Environment & Society			
MAST 672/ECON 670 Applied Policy Analysis			
MAST/ECON 867 Valuing the Environment			
MAST 670 US Ocean and Coastal Policy			
MAST/ECON 676 Environmental Economics			
MAST/UAPP 663 Decision Tools for Policy Analysis			
POSC 818 Environmental Politics and Policy			
UAPP 611 Regional Watershed Management			
UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)			
UAPP 628 Issues in Land Use and Environmental Planning			
UAPP 667 Field Seminar in Water Policy			
Research Methods Courses (3)		d) Research Methods	
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)		
	PLSC 667 Interdisciplinary Seminar (1)		
<div>Statistics, Analysis &amp; Techniques (3) [Select three credits from the category Statistics, Analysis &amp; Techniques]</div>	e) Statistics, Analysis & Techniques:		
	CHEG 604 Probability and Statistics for Engineering Problem Solving		
	FREC/STAT 608 Statistical Research Methods		
	FREC 615 Advanced Prices and Statistics		
	FREC/STAT 674 Applied Database Management		
	FREC 807 Mathematical Programming with Economic Applications		
	GEOG 671 Advanced Geographic Information Systems		
	MAST 681 Remote Sensing of Environment		
	MEEG 690 Intermediate Engineering Mathematics		
	STAT 657 Statistics for Earth Sciences		
	STAT 675 Logistic Regression		
	UAPP 816 Advanced Social Statistics		
	UAPP 691 Quantitative Analysis in Public & NP Sectors		
	UAPP 652 Geographic Information Systems in Public Policy (1)		
Directed Research/Special Problem/Internship/Independent Study (9)			
Dissertation (9)			

**Table 2. M.S. Requirements**

<b>MS in Water Science &amp; Policy – Course Curriculum (30 credits)</b>	
<p><b>Select 24 credits, with at least 3 credits from each category.</b></p>	<b>a) Physical Sciences</b>
	BREG 623 Advanced Storm water Management
	CIEG 698 Groundwater Flow and Contaminant Transport
	GEOG 632 Environmental Hydrology
	GEOG 656 Hydroclimatology
	GEOG 651 Microclimatology (4)
	GEOL 628 Hydrogeology
	GEOL 611 Fluvial Geomorphology
	PLSC 603 Soil Physics
	<b>b) Chemical/Biological Sciences</b>
	BREG 621 Nonpoint source pollution
	BREG 667 Watershed Hydrochemistry
	CHEM/MAST 683 Environmental Chemistry
	CIEG 632 Chemical Aspects of Environmental Engineering
	CIEG 636 Biological aspects of Environmental Engineering
	CIEG 668 Principles of Water Quality Criteria
	GEOG 631 Watershed Ecology
	GEOG 667 Watershed Hydro-Ecology
	PLSC 608/CHEM 608 Environmental Soil Chemistry
	<b>c) Policy</b>
	ENEP 626 Climate Change: Science, Policy and Political Economy
	ENEP 666 Topics in Sustainable Development
	ENEP 810 Political Economy of the Environment
	ENEP 868 Sustainable Water Policy Research
	ENEP 870 Sustainable Water Policy Readings
	GEOG 617 Seminar in Climate Change
	GEOG 649 Environment & Society
	MAST 672/ECON 670 Applied Policy Analysis
	MAST/ECON 867 Valuing the Environment
	MAST 670 US Ocean and Coastal Policy
	MAST/ECON 676 Environmental Economics
	MAST/UAPP 663 Decision Tools for Policy Analysis
	POSC 818 Environmental Politics and Policy
	UAPP 611 Regional Watershed Management
	UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)
	UAPP 628 Issues in Land Use and Environmental Planning
	UAPP 667 Field Seminar in Water Policy
	<b>d) Research Methods</b>
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)
	PLSC 667 Interdisciplinary Seminar (1)
	<b>e) Statistics, Analysis &amp; Techniques:</b>
	CHEG 604 Probability and Statistics for Engineering Problem Solving
	FREC/STAT 608 Statistical Research Methods
	FREC 615 Advanced Prices and Statistics
	FREC/STAT 674 Applied Database Management
	FREC 807 Mathematical Programming with Economic Applications
	GEOG 671 Advanced Geographic Information Systems
	MAST 681 Remote Sensing of Environment
	MEEG 690 Intermediate Engineering Mathematics
	STAT 657 Statistics for Earth Sciences
<b>Directed Research Option (3)</b> With advisor approval, MS students may opt to carry out directed research, in lieu of one course, within categories a, b, or c above.	
<b>Thesis (6)</b>	

## B. COMMITTEES AND DIRECTOR

The development, administration and progress assessment of the overall graduate program in Water Science & Policy will be guided by the Program Director, Dr. Shreeram Inamdar, and the Program Committee, as outlined below.

Table 3. Water Science & Policy Program Committee

Member	College	Department	Expertise
Inamdar, Shreeram Program Director	Agriculture & Natural Resources	Bioresources Engineering	Hydrology and Biogeochemistry of watersheds; sustainable watershed management
Claessens, Luc	Earth, Ocean & Environment	Geography	Hydrology and ecosystem processes; biogeochemistry; water resources engineering
Duke, Joshua	Agriculture & Natural Resources	Food and Resource Economics	Land use, natural resource and environmental economics; law and economics; property rights
Imhoff, Paul	Engineering	Civil & Environmental Engineering	Transport of fluids and contaminants in multiphase systems; mass transfer processes in soil, groundwater, surface water, and in landfills; and mathematical modeling.
Kauffman, Gerald	Arts & Sciences	School of Public Policy & Administration	Water supply, water quality, policy, droughts and floods. Watershed planning/mgt.
Leathers, Daniel	Earth, Ocean & Environment	Geography	Meteorology, Hydrology, Water Resources, Climate Change and Variation
Levia, Delphis	Earth, Ocean & Environment	Geography	Ecohydrology, forest biogeochemistry, snow science, field methods and instrumentation.
Michael, Holly	Earth, Ocean & Environment	Geology	Groundwater-surface water interaction in dynamic coastal systems; water in developing countries; geostatistical modeling
Sparks, Donald	Agriculture & Natural Resources	Plant and Soil Sciences	How contaminants, (e.g., metals) bind to soils and move into water; remediation strategies for contaminated soils.

### B.1. WATER SCIENCE & POLICY PROGRAM COMMITTEE

The Program Committee will oversee admissions and advise the development and progress assessment of the graduate program in Water Science & Policy. The committee consists of faculty members from all participating Colleges in this degree program.

### B.2. DIRECTOR

The Director of the graduate program in Water Science & Policy will be responsible for the overall implementation, quality and progress of the degree program, advised by the Program Committee.



## **C. SATISFACTORY PROGRESS**

### **C.1. FACULTY ADVISOR**

Students are required to choose an appropriate Faculty Advisor from a list of affiliated faculty members participating in the degree program. Master of Science students may have an appropriate Faculty Advisor appointed by the Director of the graduate program in Water Science & Policy. The participating faculty members are faculty approved by the Program Committee to advise students and/or serve as research mentors or co-mentors.

The Faculty Advisor will be the primary contact of the student for questions and advice. The student will develop a plan of study for the program with the Faculty Advisor before the beginning of the second semester. The Director of the graduate program in Water Science & Policy will verify that the student has completed the requirements for the program and will approve the application for the degree upon successful completion of the requirements.

### **C.2. ACADEMIC LOAD**

Full-time students are expected to complete the MS program (30 credits) within two years. The program may be completed over a longer time frame for part-time students. Students in the Ph.D. program (36 credits) will typically complete the program in four to six years.

Students enrolled in at least 9 credit hours or in sustaining credit are considered full-time students. Those enrolled for fewer than 9 credit hours are considered part-time students, although students holding assistantships are considered full-time with six credits. Generally, a maximum load is 12 graduate credit hours; however, additional credit hours may be taken with the approval of the student's adviser and the Office of Graduate and Professional Education. A maximum course load in either summer or winter session is 7 credit hours. Permission must be obtained from the Office of Graduate and Professional Education to carry an overload in any session.

### **C.3. TRANSFERABILITY**

Previous graduate level courses (a maximum of 9 credit hours) will be considered toward completion of Ph.D. course requirements, subject to approval by the Program Committee.

### **C.4. MASTER'S DEGREE REQUIREMENTS**

#### **M.S. Requirements**

The development of a program of study will be the joint responsibility of the student in consultation with the major advisor. The student will select a three-person thesis committee that includes the student's major advisor and one other member from the Water Science and Policy program. The two program members should be from different concentrations (i.e., one each from the Water Science and Water Policy groups). The thesis committee needs to be established before the beginning of the student's second semester in the program. The names of the thesis committee members should be submitted to the Program Committee for approval.

M.S. Thesis students must complete 24 credit hours of course work and 6 credit hours of thesis (a total of 30 credits). Specific course requirements for the M.S. in Water Science and Policy are described above in Section B, Course Curriculum. All full-time MS students are required to complete the degree requirements in six semesters or fewer. Students are expected to write and successfully defend the thesis to receive the degree.

Advancement to degree candidacy is contingent upon successful completion and presentation of the thesis proposal. The thesis proposal should be presented to the Thesis Committee for approval within the first two semesters in the program. The completed thesis will be presented to the Thesis Committee in typewritten form at least two weeks before the scheduled oral defense. The oral defense of the student thesis will be publicly announced and all program members will be notified at least one week prior to the defense date.

The maximum time for the completion of the MS program is 5 years from the time of entry.

## **C.5. PH.D. REQUIREMENTS**

### **Ph.D. Requirements**

The development of a program of study will be the joint responsibility of the student in consultation with the graduate advisor. The student will select a five-person Dissertation Committee that includes the student's major advisor and at least one other faculty member from the Water Science and Policy program. The two program members should be from different disciplines (i.e., one each from the Water Science and Water Policy groups). The Dissertation Committee needs to be established within the first year of study in the program. The names of the Committee members should be submitted to the Program Committee for approval.

Ph.D. students must complete 18 credit hours of course work, plus 9 credit hours of research, and 9 credit hours of thesis (a total of 36 credits). Specific course requirements for the Water Science and the Water Policy concentrations are described above in Section B, Course Curriculum. Students must maintain a minimum of 3.0 cumulative GPA in order to receive the degree. Course with a grade below a C will not be counted towards the degree. The program of study must be submitted before the end of the first year to the graduate advisor for approval. Previous graduate-level coursework will be considered toward Ph.D. course requirements, subject to the approval of the Program Committee.

The qualifying examination will include written and oral portions. The student's graduate advisor will chair and administer the exam and the content of the exam (written and oral) will be decided jointly by the student's Dissertation Committee. The exam will be graded by the Dissertation Committee and each member of the committee will provide a single grade (including written and oral sections) of PASS or FAIL. A failure in the exam will result in dismissal from the PhD program. Upon successful completion of the qualifying exam, the student is certified as a candidate for the doctoral degree. The graduate advisor will notify the Program Committee on the result of the qualifying exam.

Upon the recommendation of the Dissertation Committee the student may be admitted to candidacy for the Ph.D. degree. The stipulations for admission to doctoral candidacy are that the student has (1) had a program of study approved, (2) completed one academic year of full-time graduate study in residence at the University, (3) passed the program's qualifying examination, (4) demonstrated the ability to do research, and (5) had a research project accepted by the Dissertation Committee.

The student must submit a research proposal prior to initiating dissertation research. A pre-proposal should be prepared within the first year and should be shared with the Dissertation Committee (preferably at the time of formation of the committee). A formal, more detailed, proposal should be developed and submitted to the Dissertation Committee for approval. After approval by the Dissertation Committee, the Program Committee will be notified and a copy of the proposal will be placed in the program records.

The final examination of the PhD degree will involve approval of the written dissertation and an oral defense of the candidate's dissertation. The written dissertation will be submitted to the Dissertation Committee and the Water Science & Policy Program office at least three weeks in advance of the oral defense date. The oral defense date will be publicly announced at least two weeks prior to the scheduled date. The oral presentation will be open to the public and all members of the Water Science and Policy program. The Dissertation

Committee will approve the candidate's dissertation. The student and graduate advisor will be responsible for making all corrections to the dissertation document and for meeting all Graduate School deadlines for submission.

The maximum time for the completion of the PhD program is 10 years from the time of entry.

#### **C.6. GRADE REQUIREMENTS**

Only graduate courses completed with a grade of B- or higher count towards the requirements of the MS and PhD program in Water Sciences and Policy. Students must obtain at least a 3.0 cumulative grade point average in the courses in the curriculum to receive the degree.

#### **C.7. CONSEQUENCES OF UNSATISFACTORY ACADEMIC PROGRESS**

The Water Science & Policy Program Committee will meet at least once each semester to evaluate each student's progress. If a student is failing to make satisfactory progress towards a degree, the committee will recommend suitable action to the Director of the graduate program in Water Science & Policy. Possible actions include (but are not limited to): (i) requirement for additional courses, (ii) suspension of financial support, and (iii) recommendation for dismissal.

#### **C.8. STANDARDS OF STUDENT CONDUCT**

All graduate students are subject to University of Delaware regulations regarding academic honesty. Violations of the UD regulations regarding academic honesty or other forms of gross misconduct may result in immediate dismissal from the Program.

#### **C.9. DISMISSAL**

The procedures for dismissal as detailed in the University Catalog will be followed. Briefly, the Graduate Committee will report its recommendation and reason for dismissal to the Director of the Water Science and Policy program. The Director will make a recommendation to the Office of Graduate Studies, who will decide whether to dismiss the student. The student may appeal this decision to the Office of Graduate Studies, following the procedure given in the University Catalog.

#### **C.10. GRADUATE STUDENT GRIEVANCE PROCEDURES**

Students who feel that they have been graded inappropriately or receive what they perceive as an unfair evaluation by a faculty member may file grievances in accordance with University of Delaware policies. Students are encouraged to contact the Director of the graduate program in Water Science & Policy prior to filing a formal grievance in an effort to resolve the situation informally.

#### **C.11. ATTENDANCE AT CONFERENCES AND PROFESSIONAL MEETINGS**

The Water Science & Policy program encourages students to attend conferences and professional meetings. They provide opportunities to meet future employers and colleagues, and can offer specialized training beyond course work.

## IV. FINANCIAL AID

### A. FINANCIAL AWARDS

Admission to the graduate program in Water Science & Policy does not automatically entitle an applicant to financial aid. Students may seek financial aid opportunities, such as fellowships or scholarships from sources within the University and from private and federal agencies. Interested students should check the Office of Graduate Studies website for the most current opportunities.

Financial aid is awarded on a competitive basis from the pool of admitted applicants. The University of Delaware's policies apply to all forms of financial aid. Please refer to the University Policies for Graduate Student Assistantships and Fellowships.

Students in the Water Science and Policy program may apply for Graduate Assistantships:

**Research Assistantships (RAs)** are generally funded by research grants and contracts provided by external funding agencies. Students may be supported as an RA through their Faculty Advisor's research funds after their first year. A research assistantship provides full tuition and a stipend. The RA's advisor is responsible for defining the student's responsibilities and for evaluating the student's performance. The amount of service or research may vary from week to week but the average is usually expected to be 20 hours per week.

**Teaching Assistantships (TAs)** are offered for graduate students to perform teaching and other instructional activities by individual departments. The amount of service may vary from week to week but the average is usually expected to be 20 hours per week. A teaching assistantship provides full tuition and a stipend. Award of TA will be decided by the primary advisor and their department.

Preference for graduate student stipends will be given to students in the PhD Program. Students receiving full stipends will be expected to work 20 hours per week on faculty projects and students are expected to maintain full-time status.

### B. CONTINUATION OF FINANCIAL AID

Students who are awarded financial aid must maintain satisfactory academic progress with satisfactory performance of assistantship duties (when applicable). Satisfactory academic progress includes registering for a minimum of 9 graduate-level credits each Fall and Spring semester, and maintaining a minimum cumulative 3.0 GPA.

The Faculty Advisor will establish the RA's responsibilities and performance standards. In the event of an unsatisfactory performance by an RA, the advisor will notify the student and the Program Committee at least four weeks prior to terminating the assistantship.

The Director of the course in which the student teaches will establish the TA's responsibilities and performance standards. In the event of an unsatisfactory performance by a TA, the Course Director will notify the student and the Program Committee of the academic department offering the course. The Committee may recommend termination of the assistantship to the Department Chair.

## **PART III**

## **PROPOSAL**

## I. DESCRIPTION

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are putting immense pressure on the supply and quality of our water resources. Addressing these complex challenges and finding solutions will require a comprehensive, integrated and interdisciplinary approach. Not only do we have to address the physical, chemical and biological aspects of these problems but also make sure that the proposed solutions are socially acceptable, economically viable, and environmentally sustainable. The National Science Foundation, National Academy of Sciences, Congressional Research Service, USGS, NOAA, and USEPA have all concluded that a new interdisciplinary education and research approach is needed that integrates science and policy to address society's emerging challenges in water sustainability. An interdisciplinary graduate program in Water Science and Policy at the University of Delaware would address this challenge by training students and professionals who can think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

A graduate program in Water Science and Policy is well aligned with the strategic priorities at the University, including an emphasis on environmental research, the plans underway to hire six to eight environmentally focused faculty, and the University's *Initiative for the Planet*, all within the University's *Path to Prominence*.

The vision is a university-wide graduate program that will attract students to many departments across the campus. The students will be located within individual departments and will work with their individual advisors who will also be affiliated with the program. The students will be required to meet the specific qualifications of the program to be awarded the degree in Water Science & Policy.

The graduate program in Water Science & Policy is synergistic with other programs on campus, and draws almost entirely upon existing courses. An experimental, team-taught course is included, entitled "Research Methods in Water Science and Policy" that would involve field and lab experiences, as well as a companion one-credit seminar series.

The academic deans and chairs of Colleges and Departments involved have provided their enthusiastic support to establish a cross-college program. Water Science & Policy will be housed in the College of Agriculture & Natural Resources. Dr. Shreeram Inamdar, Associate Professor, Department of Bioresources Engineering, has been selected as faculty program director by the program committee. CANR will also provide administrative support to the program director to help manage day-to-day program requirements.

The availability of high quality water to sustain human activities and ecosystem health is among the most critical global challenges of the 21<sup>st</sup> century, given pressures on water resources due to climate change, contaminants, population growth, hydropolitics, conservation issues and infrastructure challenges. Solutions to complex problems of water quantity and quality will require both scientific understanding and implementation through effective policy. Scientists, engineers and policy experts need to understand and predict the interactions of Earth's water system with climate change, land use, the built environment and ecosystem function and services. They will need to determine how the built water systems and our governance systems can be made more reliable, resilient and sustainable in the face of diverse and often conflicting needs.

Despite its name, the Earth is a water planet. However, pressure on water resources is growing, increasing the need for understanding water availability, quality and dynamics. The impacts of climate change and human activity have created an urgent need for experts who bring both depth and breadth of experience, and a systemic perspective to the science and policy of water at the local, regional, national, and international scales.

The program in Water Science and Policy at the University of Delaware is designed to meet this increasing national and international demand for interdisciplinary water experts and to provide students with an educational opportunity that crosses traditional disciplinary and organizational boundaries. Due to the

interdisciplinary nature of water sciences and policy, experts in these fields within the University of Delaware are housed in many Colleges and Departments and affiliated centers and institutes on campus; thus, the faculty affiliated with the program may be in one of several science, engineering or social science disciplines.

An ensemble of three degree options is proposed; 1) the PhD in Water Science & Policy, Water Science Concentration; 2) the PhD in Water Science & Policy, Water Policy Concentration; and 3) the Master of Science in Water Science & Policy.

Doctoral students in the Water Science Concentration complete course requirements and carry out research that emphasizes science and engineering, but that provides exposure to policy tools and processes. Doctoral students in the Water Policy Concentration complete course requirements and carry out research that emphasizes economics and public policy, but that provides exposure to relevant science and engineering areas. Students in both Concentrations will have the opportunity to pursue directed research, a special problem, independent study or internship as part of required work.

Master of Science students in Water Science & Policy complete a set of course requirements involving both science and policy, and complete a thesis.

The Water Science & Policy program aims to train the next generation of researchers and professionals who will play a key role in multi- and interdisciplinary teams, bridging physical, chemical, biological and policy sciences. The program will be administered through its academic home, the College of Agriculture & Natural Resources. The scientific curriculum will build upon the research and educational strength from departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Business and Economics, Earth, Ocean & Environment, and Engineering. The program will be synergistic with existing degree programs, providing a critical component to University's strategic priority in environmental research and education, its *Initiative for the Planet*, and serving as a pillar of UD's *Path to Prominence*.

## **II. RATIONALE AND DEMAND**

While there are many experts in the fields of water sciences and policy at the University of Delaware they are dispersed throughout several Colleges and Departments on campus. There is no coordinated body or program that unifies this group and provides a means to maximize collaborative research and education.

The University of Delaware currently does not offer a specialized graduate degree in Water Science & Policy, although related courses have been taught in several schools and departments for a number of years. We propose to develop a graduate program in Water Science & Policy, encompassing the PhD, with both a Water Science and Water Policy concentration, and a Master of Science, with thesis. The rationale for the program:

- Water Science & Policy is an essential 21<sup>st</sup> century environmental thrust in academia, industry, and government, and affects public policy decisions across the globe;
- The program will build upon research strengths and infrastructure at the University of Delaware in departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering. The program will capitalize on existing strengths of the University and add coherence to the existing body of water science and water policy experts.
- An interdisciplinary graduate program in Water Science & Policy will enhance graduate student recruitment and help to attract and retain strong faculty.
- A cross-college program in Water Science & Policy will provide opportunities for interactions among researchers from diverse disciplines.
- The program will provide a foundation for large-scale educational funding opportunities such as the National Science Foundation Integrative Graduate Education and Research Traineeship (IGERT).

- The program will offer graduate education in a discipline essential for UD as a major research university, providing a critical component within the University’s strategic priorities in energy, environment, and life and health sciences. Indeed the program aligns with the University strategic plan to “*engage closely with the critical issues of our day, to increase the global impact of the University, and to raise its prominence in the world.*”

## **A. INSTITUTIONAL FACTORS**

### **A.1. COMPATIBILITY WITH UNIVERSITY ACADEMIC PRIORITIES**

A strong educational program in Water Science & Policy will contribute to the scholarly and educational missions of the University—to *disseminate scientific, humanistic, and social knowledge for the benefit of the larger society* and to produce graduates who *are prepared to contribute to a global society, addressing the critical needs of the state, nation and global community.*

### **A.2. PLANNING PROCESS**

In the fall of 2010, a faculty working group requested the support of the Delaware Environmental Institute (DENIN) to develop the interdisciplinary Water Science & Policy graduate program. The faculty working group brought strong science, engineering and policy expertise, and included representatives from four colleges: Agriculture and Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering. DENIN staff Jeanette Miller and Amy Broadhurst facilitated working sessions, synthesized discussion, recruited group members across colleges, coordinated with Graduate & Professional Studies and helped to develop the proposal with the Water Science & Policy group for approval by University leadership.

The working group selected Dr. Shreeram Inamdar, Associate Professor, Department of Bioresources Engineering, to serve as the Program Director, and established a Water Science & Policy Program Committee to oversee program admissions, advising and progress assessment of students.

The resulting plan offers both academic rigor as well as flexibility for students and faculty advisors to tailor the program to research interests and career objectives. The graduate program in Water Science & Policy is proposed with three degree options: 1) the PhD, with a water science concentration; 2) the PhD, with a water policy concentration; and 3) the Master of Science, with thesis.



**Table 1.** Water Science & Policy Program Committee

Member	College	Department	Expertise
Claessens, Luc	Earth, Ocean & Environment	Geography	Hydrology and ecosystem processes; biogeochemistry; water resources engineering
Duke, Joshua	Agriculture & Natural Resources	Food and Resource Economics	Land use, natural resource and environmental economics; law and economics; property rights
Imhoff, Paul	Engineering	Civil & Environmental Engineering	Transport of fluids and contaminants in multiphase systems; mass transfer processes in soil, groundwater, surface water, and in landfills; and mathematical modeling.
Inamdar, Shreeram (Program Director)	Agriculture & Natural Resources	Bioresources Engineering	Hydrology and Biogeochemistry of watersheds; sustainable watershed management
Kauffman, Gerald	Arts & Sciences	School of Public Policy & Administration	Water supply, water quality, policy, droughts and floods. Watershed planning/mgt.
Leathers, Daniel	Earth, Ocean & Environment	Geography	Meteorology, Hydrology, Water Resources, Climate Change and Variation
Levia, Delphis	Earth, Ocean & Environment	Geography	Ecohydrology, forest biogeochemistry, snow science, field methods and instrumentation.
Michael, Holly	Earth, Ocean & Environment	Geology	Groundwater-surface water interaction in dynamic coastal systems; water in developing countries; geostatistical modeling
Sparks, Donald	Agriculture & Natural Resources	Plant and Soil Sciences	How contaminants, (e.g., metals) bind to soils and move into water; remediation strategies for contaminated soils.

### **A.3. SIGNIFICANT IMPACT ON OTHER UNIVERSITY PROGRAMS**

The positive impact of the proposed Water Science & Policy Program on University research and educational programs is multi-fold:

- It will offer interdisciplinary graduate education in an area essential for the University of Delaware as a major research university.
- It capitalizes on existing strengths at the University by synergizing related areas of expertise across colleges;
- It will create a context for faculty from the various participating disciplines across-campus to articulate the interface of their research and foster research collaborations;
- It will produce graduate students with knowledge and professional expertise in water science and policy, who can play a key role in multi- and interdisciplinary teams;
- The educational program, coupled with collaborative interdisciplinary research, will provide a solid foundation for University of Delaware to compete for training grants (such as NSF's IGERT-Integrative Graduate Education and Research Traineeship Program) and research grants from multiple federal agencies;
- The graduate program in Water Science & Policy builds a foundation for a future Professional Science Master's Program, a potential source of revenue for the University.

### **A.4. UTILIZATION OF EXISTING RESOURCES**

With strong programs in engineering, environmental science, economics, and public administration the University of Delaware provides an outstanding venue for educational programs in Water Science and Policy. The proposed curricula fully leverage the course offerings from the following departments/units across Colleges. Letters of approval from contributing department/units are attached in the appendices to this document.

- College of Agriculture & Natural Resources
  - Department of Bioresources Engineering
  - Department of Plant & Soil Sciences
  - Department of Food & Resource Economics
- College of Arts & Sciences:
  - Department of Chemistry & Biochemistry
  - School of Public Policy & Administration
  - Department of Political Science & International Relations
- College of Earth, Ocean & Environment
  - Department of Geography
  - Department of Geological Sciences
  - School of Marine Science and Policy
- College of Engineering
  - Center for Energy and Environmental Policy
  - Department of Chemical Engineering
  - Department of Civil & Environmental Engineering
  - Department of Mechanical Engineering

## **B. STUDENT DEMAND**

### **B.1. ENROLLMENT PROJECTIONS**

We project that we will have a steady increase in new students entering the Water Science & Policy Program, and will reach 10 new students per year in the steady state.

A full-time student is expected to complete the MS program (30 credits) within two years. The MS program may be completed over a longer time frame for part-time students. Doctoral students are expected to complete the program (36 credits) in four years.

### **B.2. NEEDS OF STUDENT CLIENTELES**

The graduate program in Water Science & Policy degree addresses the needs of a range of students. The program offers both academic rigor as well as flexibility, to meet the needs and interests of students and their faculty advisors. With a Master's degree option, and two Ph.D. concentrations, focusing on science or policy, students with a strong interest in water can complete a graduate degree well tailored to their career goals.

## **C. TRANSFERABILITY**

Previous graduate level courses (a maximum of 9 credit hours) can be considered toward completion of Ph.D. course requirements, subject to approval by the Program Committee.

## **D. ACCESS TO GRADUATE AND PROFESSIONAL PROGRAMS**

The graduate program in Water Science & Policy will prepare students for rewarding careers in the public, private and academic sectors. MS students will have excellent prospects in the public and private sectors, and will be well positioned to continue graduate studies at the doctoral level. Ph.D. students will be prepared to carry out interdisciplinary research, including through careers in academia.

## **E. DEMAND AND EMPLOYMENT FACTORS**

The graduate program in Water Science & Policy will be attractive to students because it prepares them for challenging careers in an expanding field. The US Bureau of Labor Statistics (BLS) 2010-2011 *Occupational Outlook Handbook* predicts employment growth of 18 percent for geoscientists and hydrologists between 2008 and 2018, faster than the average for all occupations. BLS further predicts increasing demand in the public and private sector for technical assistance and environmental management and planning expertise. Critical needs include monitoring the quality of the environment, including soil and water contamination and sea level rise. Research is needed to develop informatics, models and other predictive tools that can synthesize high-volume and heterogeneous data sources, and that draw upon multiple disciplines to make nuanced, data-driven policies. US demographic trends will also drive demand, as populations increase in environmentally sensitive coastal ecosystems, for example. ([http://www.bls.gov/oco/ocos312.htm#projections\\_data](http://www.bls.gov/oco/ocos312.htm#projections_data))

## **F. REGIONAL, STATE AND NATIONAL FACTORS**

### **F.1. COMPARABLE COURSES OF STUDY IN THE REGION OR STATE**

While there are a few graduate programs in Hydrologic and Water Sciences across the United States (see list in appendix) there is no such program in the Mid-Atlantic region. This is especially surprising considering that large-scale anthropogenic land use changes (e.g., increasing population and conversion of agricultural and forest lands to urbanizing landscapes) in this region are having tremendous impacts on our region's waters. The poor water quality of the Chesapeake Bay and its impact on the Bay food web is an excellent example. Furthermore, the Bay also provides a classic case study of how water quality management may impact social, economic and policy decisions and vice-versa. Thus, a graduate program in Water Science and Policy is urgently needed and is well positioned to address the increasing challenges associated with water resources in our region.

We believe that the UD graduate program in Water Science & Policy will emerge as a highly competitive educational opportunity based on: (i) a strong interdisciplinary curriculum, (ii) proximity to both a large number of environmental consulting firms and US government agencies, (iii) rich opportunities for thesis research projects and immersive internships.

### **F.2. EXTERNAL REQUIREMENTS**

We note that there are no formal guidelines for an interdisciplinary program in Water Science & Policy, nor are there accreditation standards. The proposed curriculum was designed based on a careful review of hydrology and policy curricula offered by other institutions. We have closely examined offered programs at selected, prominent research universities, and have recognized needs from both the student and employer perspectives. The proposed curriculum compiles the information gathered from these resources into one carefully tailored program.

## **G. OTHER STRENGTHS**

### **G.1. SPECIAL FEATURES**

A special feature of the proposed program is the close collaboration among participating faculty who conceived of and developed this interdisciplinary graduate program. Going forward, this collaboration will continue in the form of the governing body, the Program Committee.

The University of Delaware offers superb laboratory, informatics, library, environmental sensing and shared core instrumentation facilities. Delaware is ideally located near government agencies and NGOs in Washington, DC and New York.

The program faculty also solicited input from their own graduate students on the direction and framework for this program. Thus, many of the ideas developed and proposed in this program come from the students themselves!

In addition to academia, this program will also encourage faculty and student interactions with other water professionals in research institutions, local, state and federal governments (e.g., Delaware Geological Survey, US Geological Survey, US Fish and Wildlife Service, etc.) as well as private industry. Such exchanges would not only broaden and enrich the educational experience of students and faculty but also help develop partnerships that will be beneficial to the future professional development of the students.

Many of the program faculty have strong and fruitful international projects and collaborations. Partnerships also include institutions associated with the United Nations. Students will be encouraged to use these opportunities to conduct research and/or internships at these international institutions and locations.

Program faculty will also facilitate and encourage student interactions with regional environmental organizations and agencies such as the Chesapeake Bay Program (CBP). This exchange will occur via seminars, workshops, and study tours.

## **G.2. COLLABORATIVE ARRANGEMENTS**

No collaborative arrangement is required.

# **III. ENROLLMENT, ADMISSIONS AND FINANCIAL AID**

## **A. ENROLLMENT**

There is no need to limit enrollment due to resources. Enrollment is estimated at 10 new students per academic year in the steady state. Based on the entrance requirements and specified prerequisites, students may enroll in the program with a regular status or provisional status:

- **Regular status** is offered to students who meet all of the established entrance requirements, who have a record of high scholarship in their fields of specialization, and who have the ability, interest, and maturity necessary for successful study at the graduate level in a degree program.
- **Provisional status** is offered to students who are seeking admission to a degree program but with deficiencies in their backgrounds, as determined by the faculty Program Committee. The deficiencies are ordinarily remedied by satisfactory performance in a course in the specific area of the deficiency. Satisfactory performance in the areas of deficiency stipulated in the letter of provisional admission will result in a change of status from provisional to regular status.

## **B. ADMISSION REQUIREMENTS**

Admission to graduate programs is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

To be admitted to the graduate program applicants should meet the following requirements:

1. A completed University of Delaware Graduate Studies application. In the application, prospective students should indicate clearly whether they are applying for the MS or the Ph.D. program (select the Water Science or the Water Policy concentration). Students may apply to the program prior to arranging for a faculty advisor; however, all students in the program will need the agreement of a program faculty member to serve as advisor for admission to the program.
2. A personal statement is required in the Graduate Studies application, and should discuss the following questions:
  - a. What are your specific research and educational goals?
  - b. What are your long-term professional career objectives?
  - c. How do you see this program assisting you with achieving your objectives?

- d. What is the name of the faculty member (affiliated with the program) who has agreed to be advisor?
3. Graduate Record Examination Scores are required (a minimum of 1050 on the VERBAL and QUANTITATIVE is desirable). Subject GRE scores are not required.
4. Official, up-to-date transcripts of all undergraduate and graduate programs. A minimum of 3.0/4.0 is required in the major.
5. Three letters of recommendation from individuals knowledgeable of the applicant's academic preparation and potential ability as a graduate student.
6. International students must take the Test of English as a Foreign Language (TOEFL) (Minimum Score: 550 paper test, 213 computer test or 79 on Internet-based tests.) TOEFL scores more than two years old cannot be considered official.

A graduate student applicant must, at the time of admission, have a faculty advisor who has agreed to direct and advise a program of study.

Applicants for the Ph.D. program will typically have an M.S. degree in a related field. Direct admission to the Ph.D. program immediately after a B.S. degree will only be considered for exceptionally qualified candidates, as determined by the Program Committee. These candidates will, however, have to complete all the course requirements associated with the Water Science and Policy M.S. program prior to starting the Ph.D. curriculum. Prior graduate coursework will be considered toward Ph.D. course requirements, with the approval of the Program Committee.

### **Change of Classification and Transfer Students**

Students that are currently matriculated in other degree programs should complete a “Change of Classification” Form to seek approval to be admitted into the Water Science and Policy Program. The Program Committee will evaluate the change in classification and transfer requests on a case-by case basis to determine if the applicant will need to complete a full application form submitted to the Office of Graduate and Professional Education. All transfer students will still have to meet the requirements listed above.

### **Application Deadlines**

Admission decisions are made on a rolling basis as and when applications are complete. The application deadlines are:

- Fall Semester: July 1<sup>st</sup> (regular application); March 1<sup>st</sup> (financial aid)
- Spring Semester: December 1<sup>st</sup> (regular application); October 1<sup>st</sup> (financial aid)

## **C. FINANCIAL ASSISTANCE**

Financial assistance for students in the program is available on a competitive basis. Preference for graduate student stipends will be given to students in the PhD Program, followed by students in the MS program. Students receiving full stipends will be expected to work 20 hours per week on faculty projects and students are expected to maintain full-time status.

## **IV. Curriculum Specifics**

### **M.S. Requirements**

The development of a program of study will be the joint responsibility of the student in consultation with the major advisor. The student will select a three-person thesis committee that includes the student's major advisor and one other member from the Water Science and Policy program. The two program members should be from different concentrations (i.e., one each from the Water Science and Water Policy groups). The names of the thesis committee members should be submitted to the Program Committee for approval.

M.S. students must complete 24 credit hours of course work and 6 credit hours of thesis (a total of 30 credits). Students must maintain a minimum of 3.0 cumulative GPA in order to receive the degree. Courses with a grade below a C will not be counted toward the degree. All full-time MS students are required to complete the degree requirements in six semesters or fewer. Students are expected to write and successfully defend the thesis to receive the degree.

Advancement to degree candidacy is contingent upon successful completion and presentation of the thesis proposal. The thesis proposal should be presented to the Thesis Committee for approval within the first two semesters in the program. The completed thesis will be presented to the Thesis Committee in typewritten form at least two weeks before the scheduled oral defense. The oral defense of the student thesis will be publicly announced and all program members will be notified at least one week prior to the defense date.

The maximum time for the completion of the MS program is 5 years from the time of entry.

### **Ph.D. Requirements**

The development of a program of study will be the joint responsibility of the student in consultation with the graduate advisor. The student will select a five-person Dissertation Committee that includes the student's major advisor and at least one other faculty member from the Water Science and Policy program. The two program members should be from different disciplines (i.e., one each from the Water Science and Water Policy groups). The Dissertation Committee needs to be established within the first year of study in the program. The names of the Committee members should be submitted to the Program Committee for approval.

Ph.D. students must complete 18 credit hours of course work, plus 9 credit hours of research, and 9 credit hours of thesis (a total of 36 credits). Specific course requirements for the Water Science and the Water Policy concentrations are described below in Section IV, Curriculum Requirements. Students must maintain a minimum of 3.0 cumulative GPA in order to receive the degree. Course with a grade below a C will not be counted towards the degree. The program of study must be submitted before the end of the first year to the graduate advisor for approval.

The qualifying examination should be taken before the end of the fourth semester and will include written and oral portions. The student's graduate advisor will chair and administer the exam and the content of the exam (written and oral) will be decided jointly by the student's Dissertation Committee. The exam will be graded by the Dissertation Committee and each member of the committee will provide a single grade (including written and oral sections) - PASS or FAIL. A failure in the exam will result in dismissal from the PhD program.

Upon successful completion of the qualifying exam, the student is certified as a candidate for the doctoral degree. The graduate advisor will notify the Program Committee on the result of the qualifying exam.

Upon the recommendation of the Dissertation Committee the student may be admitted to candidacy for the Ph.D. degree. The stipulations for admission to doctoral candidacy are that the student has (1) had a program of study approved, (2) completed one academic year of full-time graduate study in residence at the University, (3) passed the program's qualifying examination, (4) demonstrated the ability to do research, and (5) had a research project accepted by the Dissertation Committee.

The student must submit a research proposal prior to initiating dissertation research. A pre-proposal should be prepared within the first year and should be shared with the Dissertation Committee (preferably at the time of formation of the committee). A formal, more detailed, proposal should be developed and submitted to the Dissertation Committee for approval. After approval by the Dissertation Committee, the Program Committee will be notified and a copy of the proposal will be placed in the program records.

The final examination of the PhD degree will involve approval of the written dissertation and an oral defense of the candidate's dissertation. The written dissertation will be submitted to the Dissertation Committee and the Water Science & Policy Program office at least three weeks in advance of the oral defense date. The oral defense date will be publicly announced at least two weeks prior to the scheduled date. The oral presentation will be open to the public and all members of the Water Science and Policy program. The Dissertation Committee will approve the candidate's dissertation. The student and graduate advisor will be responsible for making all corrections to the dissertation document and for meeting all Graduate School deadlines for submission. A copy (electronic and printed hard copy) of the final completed dissertation should be provided to the program office for records.

The maximum time for the completion of the PhD program is 10 years from the time of entry.



**Table 2. PhD Program Requirements: Water Science & Policy**

PhD in Water Science & Policy (36 Credits)			
Course Areas	Water Science Concentration	Water Policy Concentration	
Water Science	9 Credits	3 Credits	
Water Policy	3 Credits	9 Credits	
Research Methods	3 Credits	3 Credits	
Statistics, Analysis & Techniques	3 Credits	3 Credits	
Directed Rsch/Special Prob./Internship/Independent Study	9 Credits	9 Credits	
Dissertation	9 Credits	9 Credits	
<div>Science Courses</div> <div>Water Science Concentr. Students (9) [Select at least 3 credits from each category.]</div> <div>Water Policy Concentr. Students (3) [Select one course from physical or chemical/biological science.)</div>	a) Physical Sciences		
	BREG 623 Advanced Storm water Management		
	CIEG 698 Groundwater Flow and Contaminant Transport		
	GEOG 632 Environmental Hydrology		
	GEOG 656 Hydroclimatology		
	GEOG 651 Microclimatology (4)		
	GEOL 628 Hydrogeology		
	GEOL 611 Fluvial Geomorphology		
	PLSC 603 Soil Physics		
	b) Chemical/Biological Sciences		
	BREG 621 Nonpoint source pollution		
	BREG 667 Watershed Hydrochemistry		
	CHEM/MAST 683 Environmental Chemistry		
	CIEG 632 Chemical Aspects of Environmental Engineering		
	CIEG 636 Biological aspects of Environmental Engineering		
	CIEG 668 Principles of Water Quality Criteria		
	GEOG 631 Watershed Ecology		
	GEOG 667 Watershed Hydro-Ecology		
	PLSC 608/CHEM 608 Environmental Soil Chemistry		
		c) Policy	
	<div>Policy Courses</div> <div>Water Science Concentr. Students (3) [Select one course.]</div> <div>Water Policy Concentr. Students (9) [Select three courses.]</div>	ENEP 626 Climate Change: Science, Policy and Political Economy	
		ENEP 666 Topics in Sustainable Development	
		ENEP 810 Political Economy of the Environment	
ENEP 868 Sustainable Water Policy Research			
ENEP 870 Sustainable Water Policy Readings			
GEOG 617 Seminar in Climate Change			
GEOG 649 Environment & Society			
MAST 672/ECON 670 Applied Policy Analysis			
MAST/ECON 867 Valuing the Environment			
MAST 670 US Ocean and Coastal Policy			
MAST/ECON 676 Environmental Economics			
MAST/UAPP 663 Decision Tools for Policy Analysis			
POSC 818 Environmental Politics and Policy			
UAPP 611 Regional Watershed Management			
UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)			
UAPP 628 Issues in Land Use and Environmental Planning			
UAPP 667 Field Seminar in Water Policy			
Research Methods Courses (3)	d) Research Methods		
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)		
	PLSC 667 Interdisciplinary Seminar (1)		
<div>Statistics, Analysis &amp; Techniques (3) [Select three credits from the category Statistics, Analysis &amp; Techniques]</div>	e) Statistics, Analysis & Techniques:		
	CHEG 604 Probability and Statistics for Engineering Problem Solving		
	FREC/STAT 608 Statistical Research Methods		
	FREC 615 Advanced Prices and Statistics		
	FREC/STAT 674 Applied Database Management		
	FREC 807 Mathematical Programming with Economic Applications		
	GEOG 671 Advanced Geographic Information Systems		
	MAST 681 Remote Sensing of Environment		
	MEEG 690 Intermediate Engineering Mathematics		
	STAT 657 Statistics for Earth Sciences		
	STAT 675 Logistic Regression		
	UAPP 816 Advanced Social Statistics		
	UAPP 691 Quantitative Analysis in Public & NP Sectors		
	UAPP 652 Geographic Information Systems in Public Policy (1)		
Directed Research/Special Problem/Internship/Independent Study (9)			
Dissertation (9)			

**Table 3. Master of Science Program Requirements: Water Science & Policy**

<b>MS in Water Science &amp; Policy (30 Credits)</b>	
Credit Hours Total	
Water Science, Policy, Statistics & Analysis	24 Credits
Thesis	6 Credits
<p><b>Select 24 credits, with at least 3 credits from each category.</b></p>	<b>a) Physical Sciences</b>
	BREG 623 Advanced Storm water Management
	CIEG 698 Groundwater Flow and Contaminant Transport
	GEOG 632 Environmental Hydrology
	GEOG 656 Hydroclimatology
	GEOG 651 Microclimatology (4)
	GEOL 628 Hydrogeology
	GEOL 611 Fluvial Geomorphology
	PLSC 603 Soil Physics
	<b>b) Chemical/Biological Sciences</b>
	BREG 621 Nonpoint source pollution
	BREG 667 Watershed Hydrochemistry
	CHEM/MAST 683 Environmental Chemistry
	CIEG 632 Chemical Aspects of Environmental Engineering
	CIEG 636 Biological aspects of Environmental Engineering
	CIEG 668 Principles of Water Quality Criteria
	GEOG 631 Watershed Ecology
	GEOG 667 Watershed Hydro-Ecology
	PLSC 608/CHEM 608 Environmental Soil Chemistry
	<b>c) Policy</b>
	ENEP 626 Climate Change: Science, Policy and Political Economy
	ENEP 666 Topics in Sustainable Development
	ENEP 810 Political Economy of the Environment
	ENEP 868 Sustainable Water Policy Research
	ENEP 870 Sustainable Water Policy Readings
	GEOG 617 Seminar in Climate Change
	GEOG 649 Environment & Society
	MAST 672/ECON 670 Applied Policy Analysis
	MAST/ECON 867 Valuing the Environment
	MAST 670 US Ocean and Coastal Policy
	MAST/ECON 676 Environmental Economics
	MAST/UAPP 663 Decision Tools for Policy Analysis
	POSC 818 Environmental Politics and Policy
	UAPP 611 Regional Watershed Management
	UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)
	UAPP 628 Issues in Land Use and Environmental Planning
	UAPP 667 Field Seminar in Water Policy
	<b>d) Research Methods</b>
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)
	PLSC 667 Interdisciplinary Seminar (1)
	<b>e) Statistics, Analysis &amp; Techniques:</b>
	CHEG 604 Probability and Statistics for Engineering Problem Solving
	FREC/STAT 608 Statistical Research Methods
	FREC 615 Advanced Prices and Statistics
	FREC/STAT 674 Applied Database Management
	FREC 807 Mathematical Programming with Economic Applications
	GEOG 671 Advanced Geographic Information Systems
	MAST 681 Remote Sensing of Environment
	MEEG 690 Intermediate Engineering Mathematics
	STAT 657 Statistics for Earth Sciences
<b>Directed Research Option (3)</b> With advisor approval, MS students may opt to carry out directed research, in lieu of one course, within categories a, b, or c above.	
<b>Thesis (6)</b>	

## V. RESOURCES AVAILABLE

### A. LEARNING RESOURCES

There are no special Learning Resources required to support this program. No new library or technology resources will be required for the graduate program in Water Science & Policy as it builds on resources and courses in the participating departments. The library's current holdings and subscriptions are sufficient as instructional materials.

### B. FACULTY/ADMINISTRATIVE RESOURCES

Faculty resources will be available to the graduate program in Water Science & Policy for course offerings from the participating departments (see letters of approval). Affiliated faculty members may serve as course directors, course instructors, and/or research mentors. The research mentors (thesis and dissertation advisors or committee members) will also serve as the Faculty Advisors who will be the primary contact for students and who will develop courses of study with the students. The faculty listed in the table below are affiliated with the graduate program.

Table 4: Affiliated Faculty, Water Science & Policy

Name	College	Department	Expertise
Balascio, Carmine	Agriculture & Natural Resources	Bioresources Engineering	Hydrologic modeling; surface water quality; storm water management
Bowman, Jacob	Agriculture & Natural Resources	Entomology & Wildlife Ecology	Wildlife restoration, techniques, biometry; conservation biology; habitat modeling & management
Cha, Daniel	Engineering	Civil & Environmental Engineering	Population dynamics of biological wastewater treatment processes; biotransformation of environmental contaminants in natural and engineered systems
Claessens, Luc	Earth, Ocean & Environment	Geography	Hydrology and ecosystem processes; biogeochemistry; water resources engineering
DeLiberty, Tracy	Earth, Ocean & Environment	Geography	Geographical information systems, climatology, remote sensing
Dentel, Steven	Engineering	Civil & Environmental Engineering	Application of colloid and interface science to water and wastewater treatment processes
DiToro, Dominic	Engineering	Civil & Environmental Engineering	Water quality modeling; water quality and sediment quality criteria models for organic chemicals, metals, mixtures; organic chemical and metal sorption models; statistical models
Duke, Joshua	Agriculture & Natural Resources	Food and Resource Economics	Land use, natural resource and environmental economics; law and economics; property rights
Geiger, Cathleen	Earth, Ocean & Environment	Geography	Impact of geophysical scale ice-water phase change on transportation and national security
Hough-Goldstein, Judy	Agriculture & Natural Resources	Entomology and Wildlife Ecology	Biological control; Plant/insect interactions; invasive plants; Insect pest management

Huang, Chin-Pao	Engineering	Civil & Environmental Engineering	Industrial wastewater management; aquatic chemistry; soil and groundwater remediation; environmental nanomaterials and processes
Imhoff, Paul	Engineering	Civil & Environmental Engineering	Transport of fluids and contaminants in multiphase systems; mass transfer processes in soil, groundwater, surface water, and in landfills; and mathematical modeling.
Inamdar, Shreeram (Program Director)	Agriculture & Natural Resources	Bioresources Engineering	Hydrology and Biogeochemistry of watersheds; sustainable watershed management
Jaisi, Deb	Agriculture & Natural Resources	Plant & Soil Sciences	Environmental biogeochemistry of both pristine and contaminated environments
Jin, Yan	Agriculture & Natural Resources	Plant & Soil Sciences	Contaminant fate and transport; water quality technology
Kauffman, Gerald	Arts & Sciences	School of Public Policy & Administration	Water supply, water quality, policy, droughts and floods. Watershed planning/mgt.
Leathers, Daniel	Earth, Ocean & Environment	Geography	Meteorology, Hydrology, Water Resources, Climate Change and Variation
Legates, David	Earth, Ocean & Environment	Geography	Hydroclimatology, precipitation and climate change, computational methods
Levia, Delphis	Earth, Ocean & Environment	Geography	Ecohydrology, forest biogeochemistry, snow science, field methods and instrumentation.
Maresca, Julia	Engineering	Civil & Environmental Engineering	Microbial responses to environmental inputs using high-throughput sequencing, bacterial genetics, and physiology
Messer, Kent	Agriculture & Natural Resources	Food & Resource Economics	Environmental conservation; provision of public goods; behavioral response to risk
Michael, Holly	Earth, Ocean & Environment	Geology	Groundwater-surface water interaction in dynamic coastal systems; water in developing countries; geostatistical modeling
Pizzuto, James	Earth, Ocean & Environment	Geology	Fluvial geomorphology
Schreuder, Yda	Earth, Ocean & Environment	Geography	Global resources, development and the environment; Sustainable development; Global climate change policies; International migration
Sparks, Donald	Agriculture & Natural Resources	Plant and Soil Sciences	How contaminants, (e.g., metals) bind to soils and move into water; remediation strategies for contaminated soils.
Wang, Young-Doo	Engineering	Center for Energy & Environmental Policy	Energy and environmental policy; economic analysis of alternative energy options; econometric applications.

Williams, Christopher	Agriculture & Natural Resources	Entomology and Wildlife Ecology	Wildlife population ecology; wildlife habitat interaction; upland game bird ecology; waterfowl ecology
Wommack, Eric	Agriculture & Natural Resources	Plant & Soil Sciences	Viral processes within natural ecosystems; viral metagenomics

The total enrollment each year in the program is projected at 20 students in the steady state. The demand from Water Science & Policy students can be absorbed by most existing classes.

Administrative resources will be available from the College of Agriculture & Natural Resources in the form of administrative assistance to support the Program Director in day-to-day administration of the program, and to support the Program Committee in their oversight role for the program. The Delaware Environmental Institute will assist with developing marketing and recruitment materials, including print and web-based materials.

## C. EXTERNAL FUNDING

Faculty affiliated with the Graduate Program in Water Science & Policy are active in research, and will support graduate students from externally funded research. The Program Committee will actively pursue larger-scale training grants (such as IGERT) to support the Program.

## VI. RESOURCES REQUIRED

### A. LEARNING RESOURCES

No new learning resources are required.

### B. PERSONNEL RESOURCES

No additional personnel resources will be requested beyond the faculty and administrative resources described in Section V.

### C. BUDGETARY NEEDS

#### C.1. PROJECTED EXPENSES

The projected expenses for the graduate program in Water Science & Policy include personnel costs for program administration, course instruction, mentoring and student scholarships, as well as costs for advertisement, materials and supplies and for hosting program activities.

	% Effort/Costs	Initial Funding
Personnel Expenses		
Program Administration		
Faculty Director	10%	CANR
Administrative Assistant	5%	CANR
Communications/Website Maintenance	5%	CANR
Fellowships		
2 Research assistantships for CANR students (for a 3 year period each)	\$120,000	CANR
Operational Expenses		
Web Design	\$1,700	DENIN (in-kind)
Brochures and Advertisement	\$1,500	DENIN
Operational Expenses Total	\$3,700	

The initial funding for the administration personnel costs is available from the initial host college – the College of Agriculture & Natural Resources (CANR) for the Faculty Director, and an Administrative Assistant. The Delaware Environmental Institute (DENIN) Communications Manager will develop web and print materials to support program recruitment and marketing. Materials will be shared across all colleges involved.

The Water Science and Policy Program Committee further recommends that financial assistance be sought from

Deans of the participating Colleges to provide tuition scholarships to outstanding students in the initial period of the program to increase the prestige and success of the program.

CANR has also committed to two graduate assistantships and tuition for 3 years each (total of 12 semesters of funding). These assistantships will be limited to graduate students whose primary advisors have a primary appointment in CANR. The assistantships will be decided by the Program Director in consultation with the Program Committee. The Program Committee hopes that other colleges will also follow the lead of CANR and contribute fellowships and assistantships to support the program.

## **C.2. BUDGET PLAN**

A budget plan should be in place and agreed upon among the Deans of the participating Colleges to cover the costs of launching the program initially, to incentivize faculty members to participate and contribute to this educational program, and to share the profit generated by the success of the program.

The proposed graduate program in Water Science & Policy is fully endorsed by the Deans of the following participating Colleges. Their letters of support are attached in Appendix II.

College of Agriculture & Natural Resources  
College of Arts & Sciences  
College of Earth, Ocean & Environment  
College of Engineering

## **VII. IMPLEMENTATION AND EVALUATION**

### **A. IMPLEMENTATION PLAN**

The graduate program in Water Science & Policy is planned for an official start in the fall semester of 2011. The Water Science & Policy Program Committee will establish policies of their operation and for the program, and coordinate with other participating departments about course offerings.

### **B. ASSESSMENT PLAN**

#### **B.1. PROGRAM OBJECTIVE**

The graduate program in Water Science & Policy aims to train the next generation of researchers and policy makers who will play a key role in multi- and interdisciplinary research and decision-making teams.

#### **B.2. CURRICULAR MAP AND LEARNING OUTCOMES**

The program has five major curriculum components:

1. Water Science, with a Physical, Chemical, and Biological Focus
2. Water Policy, with an Economics, Public Policy, Social and Management Focus
3. Research Methods
4. Statistics, Analysis and Techniques
5. Thesis or Dissertation

Students will demonstrate the following competencies at a level commensurate with graduate work. The program offers different emphases, with corresponding learning outcomes.

Ph.D. Students in Water Science & Policy, Water Sciences Concentration

1. Core competency in the fundamentals of water sciences and water policy
2. Advanced knowledge of water science and related disciplines
3. Ability to carry out independent, original research
4. Ability to use experimental, statistical and computational methods
5. Ability to recognize and appreciate the inherent connections and inter-dependence between science, economic, social and policy approaches to solving water problems
6. Ability to contribute effectively as individual and as team members in academia, industry and government
7. Competence in written and oral scientific communication

Ph.D. Students in Water Science & Policy, Water Policy Concentration

1. Core competency in the fundamentals of water sciences and water policy
2. Advanced knowledge of water policy and related disciplines
3. Ability to carry out independent, original research
4. Ability to use experimental, statistical and computational methods
5. Ability to recognize and appreciate the inherent connections and inter-dependence between science, economic, social and policy approaches to solving water problems
6. Ability to contribute effectively as individual and as team members in academia, industry and government
7. Competence in written and oral scientific communication

M.S. Students in Water Science & Policy

1. Core competency in the fundamentals of water sciences and water policy
2. Advanced knowledge of water science & policy and related disciplines
3. Ability to carry out directed research
4. Ability to use experimental, statistical and computational methods
5. Ability to recognize and appreciate the inherent connections and inter-dependence between science, economic, social and policy approaches to solving water problems
6. Ability to contribute effectively as individual and as team members in academia, industry and government
7. Competence in written and oral scientific communication



**Table of Curricular Components and Learning Outcomes**

Curriculum	Core competency in the fundamentals of water sciences and water policy	Advanced knowledge of water science/policy and related disciplines	Directed research experiences	Independent research experiences	Ability to use experimental, statistical and computational methods	Ability to recognize and appreciate the inherent connections and inter-dependence between science, economic, social and policy approaches to solving water problems	Ability to contribute effectively as individual professionals and as team members in academia, industry and government	Ability to apply training in a public or private sector internship assignment	Competence in written and oral scientific communication
Water Science Core	X	X							
Water Policy Core	X	X							
Research Methods		X	X	X		X			
Statistics, Analysis & Techniques				X	X				
Thesis/Dissertation		X	X	X	X	X	X	X	X

### B.3. ASSESSMENT PLAN

Goals	Activities	Measures	Outputs/Outcomes
Goal 1: To train graduate students in the areas of water science and policy	Recruit high quality graduate students through faculty networks of colleagues and leading researchers in the field, supported by effective online resources.	Numbers, credentials, & demographic data on student applicants	Retention and completion of degrees
	Course work covering multidisciplinary and multi-institutional training in water science policy that will enable them to solve complex environmental problems	<p>Faculty advisors evaluate student progress in coursework; students progress on schedule.</p> <p>Survey of students in program during and post-graduation on learning experiences; Students report applying knowledge from courses to work</p>	<p>Students find positions in Water Science and Policy related fields</p> <p>Students possess scientific and policy knowledge to sustain long term success in academic, industry and government careers</p>

		settings.	
	Present research findings at specialized national and international conferences, and to local business, government & citizens	Number and diversity of conferences and meetings attended and data presented	Students can communicate effectively with diverse audiences
	Exposure to distinguished scientists and leaders through lectureships and colloquia	Number of student-organized colloquia; active dialogue with symposia speakers	Students can communicate effectively with diverse audiences
Goal 2: To provide experiential training in research to prepare students for careers in water science and policy.	Conduct cutting-edge research through mentored (thesis/dissertation) projects	Research helps students secure initial employment; Students and graduates report applying knowledge from research to work settings. Students publish in journals.	Students possess scientific and policy knowledge to sustain long term success in academic, industry and government careers
	Participate in internships in public and private sectors.	Experiential training prepares students for the workplace and helps them secure their first post-graduation position	Students secure careers through expanded networks and internships provided by the program

Program improvement will be an ongoing process. The results of the assessment measures will be shared with the Program Committee, and the curriculum will be modified as necessary to achieve the goal of producing graduates who apply the knowledge, skills and abilities gained from the graduate program in Water Science & Policy to their careers.

## **VIII. APPENDIX I**

### **LETTERS OF APPROVAL FROM CONTRIBUTING DEPARTMENTS/UNITS**

#### **College of Agriculture & Natural Resources**

Dr. William Ritter, Department of Bioresources Engineering  
Dr. Blake C. Meyers, Department of Plant & Soil Sciences  
Dr. Thomas Ilvento, Department of Food & Resource Economics

#### **College of Arts & Sciences:**

Dr. Maria Aristigueta, Director, School of Public Policy & Administration  
Dr. Gretchen Bauer, Chair, Department of Political Science & International Relations  
Dr. Martha Corrozi Narvaez, Policy Scientist, Delaware Water Resources Agency  
Dr. Klaus Theopold, Chair, Department of Chemistry & Biochemistry

#### **College of Earth, Ocean & Environment**

Dr. Tracey DeLiberty, Department of Geography  
Dr. Susan McGeary, Department of Geological Sciences  
Dr. Charles Epifanio, Director, School of Marine Science and Policy

#### **College of Engineering**

Dr. John Byrne, Center for Energy and Environmental Policy  
Dr. Norman Wagner, Department of Chemical Engineering  
Dr. Harry W. Shenton, Chair, Department of Civil & Environmental Engineering  
Dr. Annette Karlsson, Chair, Department of Mechanical Engineering



February 14, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Shree:

The Department of Bioresources Engineering fully supports your efforts in the development of two new Master and Ph.D. programs in Water Science and Policy (WS&P). We welcome students from the new programs to take core Water Science and Water Policy courses as well as electives within the Department. Specifically, students will be allowed to enroll in:

BREG 423/623 Advanced Storm water Management  
BREG 421/621 Nonpoint source pollution  
BREG 667 Watershed Hydrochemistry  
BREG 667: Research Topics and Methods in Water Science and Policy (experimental new course)  
BREG 667: Seminar in Water Science and Policy (experimental new course)

We are very excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,

A handwritten signature in cursive script that reads "William F. Ritter".

William F Ritter  
Professor and Chair

8 March 2011

MEMO TO: Graduate Water Science & Policy Program

MEMO FROM: Tracy DeLiberty  
Interim Chair

A handwritten signature in blue ink that reads 'Tracy DeLiberty'.

The Department of Geography supports the new proposed program in Water Science and Policy. Given the pressuring environmental problems affecting the world's water resources, this graduate program is critical to meeting challenges in water sustainability, while also timely given the federal voice for the need to train students and professionals in both the science and policy aspects of water.

Several geography faculty including Del Levia, Luc Claessens, and Dan Leathers are excited to play an integral part of the graduate program. Additional geography faculty would like to be included as affiliated members (Tracy DeLiberty, Cathy Geiger, David Legates, Yda Schreuder). The geography courses listed as part of the graduate program are regularly taught by the geography faculty and are open to students across campus.

Thank you for including Geography as an integral planner in the proposed graduate program. We look forward to teaching in the program and guiding and mentoring the graduate students.



**CENTER FOR ENERGY AND  
ENVIRONMENTAL POLICY**



College of Education & Public Policy  
University of Delaware  
278 Graham Hall  
Newark, DE 19716-7381  
Internet: jbyrne@udel.edu  
Website: ceep.udel.edu  
Ph: 302/831-8405  
Fax: 302/831-3098

**John Byrne**  
Director and  
Distinguished Professor of  
Energy & Climate Policy

**Young-Doo Wang**  
Associate Director

**The Honorable  
Russell W. Peterson**  
Distinguished  
Policy Fellow

**Faculty and Staff**  
Judy Allarey  
Ralph Begleiter  
Allen M. Barnett  
Terri D. Brower  
Jingguang Chen  
Steven Hegedus  
Kristen Hughes  
Lado Kurdgelashvili  
William Latham  
Cecilia Martinez  
William F. Ritter  
Yda Schreuder  
Ismat Shah  
Richard T. Sylves  
Robert Warren

**Adjunct Faculty**  
Cesar Cuello  
Paul T. Durbin  
Steven M. Hoffman  
Jong-dall Kim  
Jung Ku Kim  
Hoesung Lee  
Ralph Nigro  
Subodh Wagle  
William Wallace

**Degree programs:**

**Energy and Environmental  
Policy Program (ENEP)**

Ph.D. in Energy & Environmental Policy  
Master of Energy &  
Environmental Policy (MEEP)  
B.S. in Energy & Environmental Policy

**Urban Affairs and Public  
Policy Program (UAPP)**

Ph.D. specialization in Technology,  
Environment & Society  
M.A. concentration in Energy,  
Environment & Equity

*The Center for Energy & Environmental  
Policy administers the ENEP degrees.*

March 4, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19716

Dear Shree:

The Center for Energy and Environmental Policy is pleased to support you and your colleagues' efforts to develop a new Master's and Ph.D. program in Water Science and Policy (WS&P). If adopted, we will welcome students from the new program to take core and elective courses from our ENEP program. Specifically, we will reserve seats for WS&P students in:

ENEP 626: Climate Change: Science, Policy and Political Economy  
ENEP 666: Topics in Sustainable Development  
ENEP 810: Political Economy of the Environment  
ENEP 868: Sustainable Water Policy Research  
ENEP 870: Sustainable Water Policy Readings

We are very excited to be a part of this initiative and look forward to seeing WS&P students in the classroom. We wish you all success.

Sincerely,

John Byrne  
Director and Distinguished Professor  
of Energy and Climate Policy

Young-Doo Wang  
Professor and  
ENEP Program Director



February 18, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Shree,

The Department of Civil and Environmental Engineering fully supports your efforts in the development of two new Master and Ph.D. programs in Water Science and Policy (WS&P). We welcome students from the new programs to take core Water Science and Water Policy courses as well as electives within the Department. Specifically, students will be allowed to enroll in:

CIEG 498/698 Groundwater Flow and Contaminant Transport  
CIEG 632 Chemical Aspects of Environmental Engineering  
CIEG 636: Biological aspects of environmental engineering  
CIEG 668 Principles of Water Quality Criteria

We are very excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,

A handwritten signature in blue ink, appearing to read "Harry Shenton", with a stylized flourish at the end.

Harry "Tripp" Shenton, Ph.D.  
Professor and Chair



DEPARTMENT OF CHEMISTRY  
AND BIOCHEMISTRY  
OFFICE OF THE CHAIRMAN

102 Brown Laboratory  
University of Delaware  
Newark, Delaware 19716-2522  
Ph: 302/831-1247  
Fax: 302/831-6335

February 7, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Dr. Inamdar,

The University's Department of Chemistry and Biochemistry acknowledges your efforts in the development of two new Master and Ph.D. programs in Water Science and Policy (WS&P). If these programs are instituted, we shall welcome students from them to take electives within this Department. Specifically, students will be allowed to enroll in:

CHEM/MAST 683 Environmental Chemistry  
CHEM 608/PLSC608 Environmental Soil Chemistry

We are pleased to facilitate your initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

With best regards,

A handwritten signature in black ink that reads "Klaus H. Theopold".

Klaus H. Theopold  
Professor and Chair





College of Earth, Ocean,  
& Environment  
SCHOOL OF MARINE SCIENCE & POLICY

Charles E. Epifanio  
Harrington Professor and School Director  
Hugh R. Sharp Campus  
700 Pilottown Road  
Lewes, DE 19958  
Phone: 302-645-4263  
Fax: 302-645-4213  
Email: [epi@udel.edu](mailto:epi@udel.edu)  
<http://www.ceoe.udel.edu/cepifanio>

February 4, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Shree,

The School of Marine Science and Policy fully supports your efforts in the development of two new M.S. and Ph.D. programs in Water Science and Policy (WS&P). We welcome students from the new programs to take core Water Science and Water Policy courses as well as electives within the Department. Specifically, students will be allowed to enroll in:

MAST 672/ECON 670 Applied Policy Analysis  
MAST 670 US Ocean and Coastal Policy  
MAST/ECON 676 Environmental Economics  
MAST/UAPP 663 Decision Tools for Policy Analysis  
MAST 681 Remote Sensing of Environment  
MAST/ECON 867 Valuing the Environment

We are very excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,

A handwritten signature in blue ink that reads 'C. E. Epifanio'.

Charles E. Epifanio  
Harrington Professor and School Director



COLLEGE OF EARTH, OCEAN, AND ENVIRONMENT

DEPARTMENT OF  
GEOLOGICAL SCIENCES

103 Penny Hall  
University of Delaware  
Newark, DE 19716-2544 U.S.A.  
Ph: 302/831-2569  
Fax: 302/831-4158  
URL: [www.geosci.udel.edu](http://www.geosci.udel.edu)

February 4, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Shree,

The Department of Geological Sciences fully supports your efforts in the development of two new Master and Ph.D. programs in Water Science and Policy (WS&P). We welcome graduate students from the new programs to take core Water Science and Water Policy courses as well as electives within the Department. Specifically, students will be encouraged to enroll in:

GEOL 428/628 Hydrogeology  
GEOL411/611 Fluvial Geomorphology

Geological Sciences is excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,

A handwritten signature in dark ink that reads "Sean McHenry".

Professor and Chair



**College of Agriculture &  
Natural Resources**

DEPARTMENT OF PLANT & SOIL SCIENCES

Dr. Blake C. Meyers  
Edward F. and Elizabeth  
Goodman Rosenberg Professor  
Chair of Department  
153 Townsend Hall  
Newark, DE 19716-2170  
Phone: (302) 831-3418  
Email: meyers@dbi.udel.edu

February 4, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Shree,

The Department of Plant & Soil Sciences fully supports your efforts in the development of two new Master's and Ph.D. degree programs in the area of Water Science and Policy (WS&P). We welcome students from the new programs to take core Water Science and Water Policy courses as well as electives within our department. Specifically, students will be allowed to enroll in the following two courses:

PLSC 603 Soil Physics  
PLSC 608/CHEM 608 Environmental Soil Chemistry

We are very excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,

A handwritten signature in black ink, appearing to read 'Blake C. Meyers'.

Blake C. Meyers, Ph.D.  
Professor & Chair

February 21, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

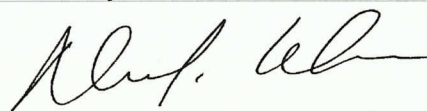
Dear Shree,

The Department of Chemical Engineering fully supports your efforts in the development of two new Master and Ph.D. programs in Water Science and Policy (WS&P). We welcome students from the new programs to take core Water Science and Water Policy courses as well as electives within the Department. Specifically, students will be allowed to enroll in:

CHEG 604 Probability and Statistics for Engineering Problem Solving

We are very excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,



Alvin B. and Julia O. Stiles Professor and Chair,  
Department of Chemical Engineering



Department of  
Mechanical Engineering

126 Spencer Laboratory  
Newark, DE 19716-3140  
Phone: 302-831-2421  
Fax: 302-831-3619  
Email: [info@me.udel.edu](mailto:info@me.udel.edu)

February 14, 2011

Professor Shreeram Inamdar  
Department of Bioresources Engineering  
University of Delaware  
Newark, DE 19711

Dear Shree,

The Department of Mechanical Engineering fully supports your efforts in the development of two new Master and Ph.D. programs in Water Science and Policy (WS&P). We welcome students from the new programs to take core Water Science and Water Policy courses as well as electives within the Department. Specifically, students will be allowed to enroll in:

MEEG 690 Intermediate Engineering Mathematics

We are very excited to be a part of this initiative and we look forward to seeing WS&P students in the classroom. We wish you great success.

Sincerely,

A handwritten signature in cursive script, appearing to read 'Anette M. Karlsson'.

Anette M. Karlsson, Ph.D.  
Chair and Professor of Mechanical Engineering



INSTITUTE FOR  
PUBLIC ADMINISTRATION

180 Graham Hall  
University of Delaware  
Newark, DE 19716-7380  
Ph: 302/831-8971  
Fax: 302/831-3488  
Email: [ipa@udel.edu](mailto:ipa@udel.edu)  
<http://www.ipa.udel.edu>

Shreeram Inamdar, Ph.D.  
Associate Professor  
Bioresources Engineering  
260 Townsend Hall  
University of Delaware  
Newark, DE 19716

February 16, 2011

Dear Dr. Inambar:

I am writing in support of a new, university-wide, interdisciplinary, graduate program on "Water Science and Policy". It is my understanding that this program will provide an opportunity to address water-related challenges and problems across the nation in an integrated approach, providing a comprehensive education for students.

I have been working as a Policy Scientist with the University of Delaware's Water Resources Agency since 2004. Through my work at the Water Resources Agency I have learned first-hand the need for collaboration and to work with multiple disciplines to complete a project.

Interdisciplinary and collaborative research and work has become increasingly common and necessary in the water resources field. Examples of such collaboration and multi-disciplinary work are prominent on the local, regional, and national levels. For example, the Water Resources Agency is working to restore fish passage to the National Wild and Scenic White Clay Creek watershed and we have been collaborating with geologists, biologists, historians, and policy scientists across campus to complete this project. On a national level I serve on the Board of Directors for the American Water Resources Association. This national professional association will be hosting a conference on Integrated Water Resources Management in June 2011. This conference will focus on an integrated approach to water resource issues and will showcase projects and research that addresses broader social, economic, and environmental goals.

Delaware is an ideal setting for this type of program due to its varied geography, diversity of water resource issues from the north to the south, and the small nature of the state that enables students to easily explore water resources throughout the state. The ability to access Delaware's policy makers at the national, state, and local levels is also a great asset for this type of program. The practical experiences that can be realized while enrolled in this program are limitless.

In closing, I highly support the new "Water Science and Policy" program and believe there is great value and necessity for such a water-focused program here in Delaware.

Sincerely,

A handwritten signature in black ink, appearing to read "Martha Corrozi Narvaez".

Martha Corrozi Narvaez  
Water Resources Agency  
Institute for Public Administration  
University of Delaware



DEPARTMENT OF  
POLITICAL SCIENCE AND  
INTERNATIONAL RELATIONS

University of Delaware  
Newark, Delaware 19716-2574  
Ph: 302/831-2355  
Fax: 302/831-4452

February 18, 2011

Dr. Shreeram P. Inamdar  
Associate Professor  
Department of Bioresources Engineering  
University of Delaware

Dear Dr. Inamdar,

Subject: Support for the Graduate Program in Water Science & Policy

This letter is in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents a critical area of research in the 21<sup>st</sup> century. It builds on strengths at the University of Delaware and will be an effective program to attract excellent students who have an interest in both the scientific aspects of water, as well as the tools needed to develop sound policy.

We welcome students to take courses in the Department, and specifically:

POSC 818 Environmental Politics and Policy.

Please keep me updated on the progress of this exciting proposal to the Faculty Senate.

Sincerely,

A handwritten signature in cursive script that reads "Gretchen Bauer".

Gretchen Bauer  
Professor and Chair  
Department of Political Science and IR

## **IX. APPENDIX II**

### **LETTERS OF SUPPORT FROM DEANS OF PARTICIPATING COLLEGES**

1. Dr. Robin W. Morgan, Dean, College of Agriculture & Natural Resources
2. Dr. George H. Watson, Dean, College of Arts & Sciences
3. Dr. Nancy M. Targett, Dean, College of Earth, Ocean & Environment
4. Dr. Michael J. Chajes, Dean, College of Engineering



Office of the Dean  
113 Townsend Hall  
Newark, Delaware 19716-2103  
Phone: 302-831-2501  
Fax: 302-831-6758  
Email: [morgan@udel.edu](mailto:morgan@udel.edu)

February 4, 2011

Dr. Shreeram P. Inamdar  
Associate Professor  
Department of Bioresources Engineering  
University of Delaware

Subject: Support for the Graduate Program in Water Science & Policy

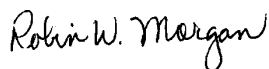
Dear Shree,

I am writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering.

The proposed program represents a critical area of research in the 21<sup>st</sup> century. It builds on strengths at the University of Delaware and promises to attract excellent students who have an interest in both the scientific aspects of water, as well as the tools needed to develop sound policy. This program will allow us to effectively leverage other investments that we are making.

The program will be an excellent interdisciplinary option for both students and faculty. Please keep me updated on the progress of this proposal to the University of Delaware Faculty Senate.

Sincerely,



Robin W. Morgan, Dean



College of Earth, Ocean,  
& Environment  
OFFICE OF THE DEAN

111 Robinson Hall  
Newark, DE 19716-3501 U.S.A.  
Phone: 302-831-2841  
Fax: 302-831-4389  
Email: [ntargett@udel.edu](mailto:ntargett@udel.edu)

February 4, 2011

Dr. Shreeram P. Inamdar  
Associate Professor  
Department of Bioresources Engineering  
University of Delaware

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shree,

I'm writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents a critical area of research in the 21<sup>st</sup> century. It builds on strengths at the University of Delaware, and promises to attract excellent students who have an interest in both the scientific aspects of water, as well as the tools needed to develop sound policy.

The program will be an excellent interdisciplinary option for both students and faculty. Please keep me updated on the progress of this proposal to the University of Delaware Faculty Senate.

Sincerely,

A handwritten signature in black ink that reads 'Nancy M. Targett'.

Nancy Targett  
Dean, College of Earth, Ocean, and Environment

9 February 2011

Dr. Shreeram P. Inamdar  
Department of Bioresources Engineering  
University of Delaware

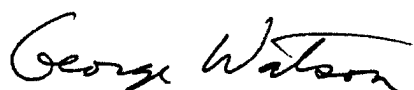
Subject: Support for the Graduate Program in Water Science & Policy

Dear Shree,

I am writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents an excellent area of interdisciplinary research for the University and our students. It builds on strengths at UD and should attract excellent students who have an interest in both the scientific aspects of water, as well as the tools needed to develop sound policy. The global internship, field-based study, and career opportunities for these graduates are promising.

Sincerely,



George H. Watson  
Dean



College of Engineering  
OFFICE OF THE DEAN

University of Delaware  
102 du Pont Hall  
Newark, DE 19716-3101  
Phone: 302-831-2401  
Fax: 302-831-8179

February 8, 2011

Dr. Shreeram P. Inamdar  
Associate Professor  
Department of Bioresources Engineering  
University of Delaware

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shree,

I'm writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents a critical area of research in the 21<sup>st</sup> century. It builds on strengths at the University of Delaware, and promises to attract excellent students who have an interest in both the scientific aspects of water, as well as the tools needed to develop sound policy.

The program will be an excellent interdisciplinary option for both students and faculty. Please keep me updated on the progress of this proposal to the University of Delaware Faculty Senate.

Sincerely,

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

Michael J. Chajes  
Professor and Dean

## **X. APPENDIX III**

### **Letters of Support from External Partners and Scientific Collaborators**

Dr. Arthur Gold, Professor of Watershed Hydrology, College of the Environment and Life Sciences, University of Rhode Island, Kingston, RI

Dr. Peter Groffman, Senior Scientist, Cary Institute of Ecosystem Studies, Millbrook, NY

Dr. George Hornberger, Distinguished University Professor, Craig E. Philip Professor of Engineering, Professor of Earth and Environmental Sciences and Director, Vanderbilt Institute for Energy and Environment, Vanderbilt University, Nashville, TN

Dr. Richard Lowrance, Research Ecologist, United States Department of Agriculture - ARS

Dr. Jeffrey J. McDonnell, Director, Institute for Water and Watersheds, Oregon State University, Corvallis, OR

Dr. Diane McKnight, Professor, Department of Civil, Environmental and Architectural Engineering, Institute of Arctic and Alpine Research, University of Colorado at Boulder, Boulder, CO

Dr. Myron Mitchell, Distinguished Professor and Director of the Council on Hydrologic Systems Science, College of Environmental Science and Forestry, State University of New York, Syracuse, NY

Dr. Saied Mostaghimi, H. E. and Elizabeth F. Alphin Professor, Associate Dean for Research and Director of VA Agricultural Exp. Station, Virginia Tech, Blacksburg, VA

Dr. Bernard Sweeney, Director, Stroud Water Research Center, Avondale, PA

February 28, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shreeram,

I'm writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents a critical area of need in the 21<sup>st</sup> century. This program will provide an excellent opportunity to address water-related challenges and problems across the nation and especially in the Chesapeake Bay and the Delmarva region.

I am particularly impressed with the interdisciplinary nature of the program. We have just finished an NSF funded IGERT Ph.D. program on Coastal Management that brought together faculty from the natural sciences, economics, communications and ethics. Our students have been highly competitive for jobs in the private and public sector. The integration of science, economic, policy, and regulatory aspects of water and watersheds is extremely timely and responds to the needs of our students, decision makers, green industry and the public.

This program will also provide a wonderful opportunity for students and faculty to interact and exchange ideas with water experts from multiple disciplines across local, state, and federal government, industry, environmental organizations and the local community.

I strongly support this program and look forward to interacting with the program faculty and the students in the near future.

Sincerely,

*Arthur J. Gold*

Arthur J. Gold, Ph.D.  
Professor of Watershed Hydrology

*George M. Hornberger  
Distinguished University Professor  
Craig E. Philip Professor of Engineering  
Professor of Earth and Environmental Sciences  
Vanderbilt University  
Nashville, TN*

February 23, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shreeram,

Thanks for sending me your proposal for a Graduate Program in Water Science & Policy that involves four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering. In my opinion, your group has identified an excellent template for adapting the standard university structure to deal with water resources issues in a modern setting.

Meeting the water needs of humans and ecosystems is perhaps one of the greatest challenges of the 21st Century. Over the last decade, it has become increasingly clear that if we are to face the water and environmental challenges of the future we must view Earth as a single, although highly complex, system that includes the atmosphere, the hydrosphere, the geosphere and the biosphere. And increasingly, the impacts of the “biosphere”, which includes humans, cannot be treated without explicit recognition of behavioral and institutional aspects of society that affect and are affected by the natural and engineered systems; the natural sciences, engineering, and economics and policy can no longer be treated as separate and distinct. Understanding coupled processes and feedbacks in the face of anthropogenic and natural changes and with sufficient accuracy to address the Nation’s and the globe’s critical problems will require synthesis across disciplines and scales. The interdisciplinary nature of your proposed program with integration of science, economic, policy, and regulatory aspects is exactly on target.

I also note that your proposed program aims to provide the opportunity for students and faculty to interact and exchange ideas with water experts from multiple

disciplines across local, state, and federal government, industry, environmental organizations and the local community. This will place you in a good position to develop the collaborations that will be needed for research programs that will be developed in response to recommendations from several recent National Academies reports that point out the need for engaging people outside the walls of the ivory tower<sup>1</sup>. In this vein as well, you have identified a critical emerging role for universities to play in coming decades.

As you can tell, I like your proposal very much and hope that you are successful in navigating it through the approval process at the University of Delaware. I look forward to keeping in touch and learning about how your work proceeds in the future.

Sincerely,

A handwritten signature in black ink, appearing to read "George", with a stylized, flowing script.

Director, Vanderbilt Institute for Energy and Environment

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<sup>1</sup> For example, a recent panel on which I served recommended the following as part of the rationale for having federal programs devote resources to integrative research. “Developing the science to support choices about climate change also requires engagement of decision makers and other stakeholders.” [NRC 2010. *Advancing the Science of Climate Change*. National Academies Press.]



February 20, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shreeram,

I am glad to write in support of your proposal to establish a Graduate Program in Water Science & Policy at the University of Delaware. I have been involved in multidisciplinary research related to water science for over 30 years and feel strongly that there is a critical need for graduate training that includes multiple scientific disciplines as well as a strong policy and outreach component. Such programs are essential for addressing critical environmental issues related to land use, climate change, water supply, and water quality and ecosystem integrity. These issues are especially critical in the Chesapeake Bay and the Delmarva region.

I am particularly impressed that your proposal includes faculty from four Colleges at the University: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering. It is essential to provide students and faculty the opportunity to interact and exchange ideas with water experts from multiple disciplines. I am also impressed with your ideas to collaborate with local, state, and federal government, industry, environmental organizations and the local community.

Your proposed approach is very consistent with two programs that I have been involved with, an IGERT program on "Water in the Urban Environment" at the University of Maryland Baltimore County (<http://www.umbc.edu/cuere/igert/>) and the Baltimore Ecosystem Study (BES) Long-Term Ecological Research (LTER) project that seeks to understand a major urban region as an ecological system. The BES project focuses on a five county metropolitan region in which watersheds are used as the stage on which to understand the reciprocal interactions of the social, biophysical, and built environments. Like your proposed program, these projects are based on the idea that there is a critical need for graduate training that includes multiple scientific disciplines as well as a strong policy and outreach component. By establishing such a program at Delaware, you will be setting up a strong platform for attracting other funding and for developing state-of-the-art research in environmental science and policy.

I strongly support this program and look forward to interacting with the program faculty and the students in the near future.

Sincerely,



Peter M. Groffman  
Senior Scientist





March 1, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shreeram,

I am excited to hear about the development of the Graduate Program in Water Science & Policy at the University of Delaware. I'm writing in support of the proposal for this graduate program.

The proposed program will fill a critical need for training graduate students to meet 21<sup>st</sup> century challenges. This program will provide an excellent opportunity to address water-related challenges and problems across the nation and globally. Given the critical water resources issues in the Chesapeake Bay, Delaware Bay, and Delmarva regions one could argue that the program is long overdue. The interdisciplinary nature of the program with integration of science, economic, policy, and regulatory aspects is especially novel and should be very attractive to prospective graduate students. I think having faculty representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering involved in the development of the Graduate Program is an excellent harbinger of the future success of the program.

Having come out of an interdisciplinary program at the University of Georgia Institute of Ecology in the 1980s, it is clear to me that solving societal problems related to water and sustainability require both good science and good science based policy. It appears that this program will also provide a unique opportunity for students and faculty to interact and exchange ideas with water experts from multiple disciplines across local, state, and federal government, industry, environmental organizations and the local community.

I strongly support this program and look forward to interacting with the program faculty and the students in the near future.

Sincerely,

A handwritten signature in black ink that reads "Richard Lowrance". The signature is written in a cursive, flowing style.

Richard Lowrance  
Research Ecologist  
USDA-ARS



State University of New York  
College of Environmental Science and Forestry

Department of Environmental and Forest Biology

February 23, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

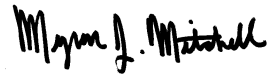
Dear Shreeram:

This letter provides my strong support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering. The proposed program addresses important areas of scientific, engineering and policy needs in the 21<sup>st</sup> century. Water resources are critical within urban, suburban and rural regions and impact a broad range of societal needs ranging local to international levels. The program at the University of Delaware will provide exceptional opportunities for addressing a broad range of water-related issues with particular focus on the Chesapeake Bay and the Delmarva region with their unique challenges on water resources.

This program will build upon previous efforts at the University of Delaware and will provide new opportunities for students and faculty to interact and exchange ideas with water experts from multiple disciplines. Participants will include stake holders from all levels of government (i.e., local, state, and federal) as well as from industry, environmental organizations and the local community.

I strongly support this program and look forward to interacting with the program faculty and the students at the University of Delaware.

Sincerely yours

A handwritten signature in black ink, reading "Myron J. Mitchell". The signature is written in a cursive style with a large initial "M".

Myron J. Mitchell

Distinguished Professor and Director of  
the Council on Hydrologic Systems  
Science



Jeffrey J. McDonnell  
*OSU Distinguished Professor and Richardson Chair in Watershed Science*

**DEPARTMENT OF FOREST ENGINEERING, RESOURCES AND MANAGEMENT**  
015 Peavy Hall, Corvallis, OR 97331-5706  
T +1-541-737-8720 | F +1-541-737-4316 | <http://www.cof.orst.edu/cof/fe/watershd>

Mar 2, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

Subject: Support for the Graduate Program in Water Science & Policy

Dear Shreeram,

I'm writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by your faculty working group from your Colleges Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean, and Environment and Engineering.

As a Director of a similar program at OSU, I can see that your proposed program clearly represents a critical area of need for the 21<sup>st</sup> century. This program will provide an excellent opportunity to address water-related challenges and problems across the nation and especially in the Chesapeake Bay and the Delmarva region. The interdisciplinary nature of the program with integration of science, economic, policy, and regulatory aspects is especially novel.

This program will also provide a wonderful opportunity for students and faculty to interact and exchange ideas with water experts from multiple disciplines across local, state, and federal government, industry, environmental organizations and the local community.

I strongly support this program and look forward to interacting with the program faculty and the students in the near future.

Sincerely,

A handwritten signature in black ink that reads "JJ McDonnell". The signature is written in a cursive, flowing style.

Jeffrey J. McDonnell  
*Director, Institute for Water and Watersheds*



# VirginiaTech

College of Agriculture  
and Life Sciences

**Office of Research and  
Virginia Agricultural Experiment Station**  
104 Hutcheson (0402)  
Blacksburg, Virginia 24061  
540/231-6336 Fax: 540/231-4163  
E-mail: [calsresearch@vt.edu](mailto:calsresearch@vt.edu)  
[www.cals.vt.edu](http://www.cals.vt.edu)

February 18, 2011

Dr. Shreeram P. Inamdar  
Associate Professor and Director, Water Science & Policy Program  
University of Delaware  
260 Townsend Hall  
Newark, DE 19716

RE: Support for the Graduate Program in Water Science & Policy

Dear Dr. Inamdar,

I am writing in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents a critical area of need in the 21<sup>st</sup> century. This program will provide an excellent opportunity to address water-related challenges and problems across the nation and especially in the Chesapeake Bay and the Delmarva region. The interdisciplinary nature of the program with integration of science, economic, policy, and regulatory aspects is especially novel.

This program will not only has the potential to bring together interdisciplinary groups of faculty from the University of Delaware to address the important water issues faced by society, it also would a wonderful opportunity for students and faculty to interact and exchange ideas with water experts from multiple disciplines across local, state, and federal government, industry, environmental organizations and the local community.

I strongly support this program and look forward to interacting with the program faculty and the students in the near future.

Sincerely,

Saied Mostaghimi  
H. E. and Elizabeth F. Alphin Professor  
Associate Dean for Research and Director of VA Agricultural Exp. Station

***Invent the Future***



February 11, 2011

Dr. Shreeram P. Inamdar  
Associate Professor  
Department of Bioresources Engineering  
University of Delaware

Subject: Support for the Graduate Program in Water Science & Policy

Dear Dr. Inamdar,

This letter is in support of the proposal for a Graduate Program in Water Science & Policy that has been developed by a faculty working group representing four Colleges at the University of Delaware: Agriculture & Natural Resources; Arts & Sciences; Earth, Ocean, and Environment; and Engineering.

The proposed program represents a critical area of research in the 21<sup>st</sup> century, and is at the heart of the mission of the Stroud Water Research Center. It builds on strengths at the University of Delaware and will be an effective program to attract excellent students who have an interest in both the scientific aspects of water, as well as the tools needed to develop sound policy.

A graduate program in Water Science & Policy will also be an excellent platform for the growing number of collaborative research projects underway between our two institutions.

The program will be an excellent interdisciplinary option for both students and faculty. Please keep me updated on the progress of this proposal to the University of Delaware Faculty Senate.

Sincerely,

A handwritten signature in black ink, which appears to read "Bernard W. Sweeney".

Bernard W. Sweeney  
President and Director

## **XI. Appendix IV – Course Descriptions**

### **Physical**

#### **BREG623: Advanced Storm Water Management (3)**

- Design of gutters, storm drain inlets, and storm drains. Design of distributed and low impact development storm-water management systems. Erosion and sediment control for site development, flood plain hydraulics and analysis.

#### **CIEG698: Groundwater Flow and Contaminant Transport (3)**

- Development and application of models for fluid flow and contaminant transport in porous media. Derivation of governing equations, analytical and numerical solutions, and application to the movement of groundwater and transport of contaminants at an actual field site.

#### **GEOG632: Environmental Hydrology (3)**

- Introduction to hydrologic science. Topics include precipitation, snowmelt, evapotranspiration, infiltration, groundwater, runoff, streamflow, water resources management, and hydrologic applications of remote sensing and geographic information systems. Case studies illustrate hydrological response to changes in land use and climate. Group studies include field measurements and computer simulations.

#### **GEOG651: Microclimatology (4)**

- Introduction to instrumentation and techniques involved in microclimatic monitoring and sampling. Field observation carried out in varying environmental situations.

#### **GEOG656: Hydroclimatology (3)**

- Study of the hydrologic cycle as it relates to water in the atmosphere and in and on the earth's surface. Hydrologic processes including precipitation, soil moisture, evapotranspiration, runoff and streamflow will be examined.

#### **GEOL611: Fluvial Geomorphology (3)**

- Hydrologic and sediment transport processes in rivers and watersheds. Morphology and evolution of rivers and watersheds. Depositional processes and evolution of floodplains. Structure and interpretation of fluvial deposits in the geologic record.

#### **GEOL628: Hydrogeology (3)**

- Principles of groundwater flow and water chemistry in varied geologic media. Evaluation of groundwater resources and assessment of environmental problems associated with groundwater use.



**PLSC603: Soil Physics (3)**

- Examines the importance of soil physics in relation to other disciplines of soil and environmental sciences. Topics include status of water in soil, fundamental principles of water flow, differences between saturated and unsaturated water flow, water balance in the field, infiltration, evapotranspiration, heat, gas and solute (contaminant) transport in soil.

**Chemical/Biological**

**BREG421/621: Nonpoint Source Pollution (3)**

- Understanding sources, transport pathways, and transformations of important pollutants and toxic chemicals generated by anthropogenic activities. Topics include transport, transformation, and fate of these pollutants in watersheds. Impacts of these pollutants on soil, forest, and aquatic ecosystems using specific case studies.

**BREG 667: Watershed Hydrochemistry (3)**

- The role of hydrology in the exports of solutes and chemicals from watersheds. Linkages and feedbacks between hydrologic and biogeochemical processes. Mechanistic conceptual models for solute transport will be emphasized. Innovative methods to characterize and quantify solutes in watersheds will be discussed.

**CHEM/MAST683: Environmental Chemistry (3)**

- Reactions in gas, liquid and solid phases of the Earth's atmosphere, hydrosphere, and geosphere, and energy fluxes and chemical exchanges across these interfaces discussed in the context of basic chemical principles. Applications to current issues such as climate change and air/water pollution discussed.

**CIEG632: Chemical Aspects of Environmental Engineering (3)**

- The principles and applications of aqueous chemistry to environmental systems. Includes a review of general chemistry, with emphasis on the structure of matter and stoichiometry; chemical thermodynamics; chemical kinetics; equilibrium reactions in homogeneous and heterogeneous solutions; applied electrochemistry and Redox reaction; and interfacial phenomena.

**CIEG636: Biological Aspects of Environmental Engineering (3)**

- Presents fundamental molecular biological concepts that pertain to cellular function in the environment and in engineered environmental treatment systems. Briefly reviews elementary organic chemical classifications.

**CIEG668: Principles of Water Quality Criteria (3)**

- Toxicological and chemical background and technical basis necessary for understanding the models of water and sediment quality criteria for individual and mixtures of organic chemicals and metals that focus on bioavailability: narcosis

models of toxicity, complexation models applied to both the water column and sediments.

**GEOG631: Watershed Ecology (3)**

- Examines key biogeochemical processes and functional ecology of wooded ecosystems. Emphasis on examination of peer-reviewed scientific literature. Topics include inter- and intrasystem transport of nutrients and effects of abiotic stressors and animals on catchment scale nutrient budgets.

**GEOG667: Watershed Hydro-Ecology (3)**

- Examines linkages between hydrology and ecosystem processes in primarily human impacted watersheds. Addresses both terrestrial and aquatic ecosystems. Particular emphasis on effect of land use and climate change, and adaptive management practices.

**PLSC/CHEM608: Environmental Soil Chemistry (3)**

- Principles of soil chemical reactions and their application to environment including: inorganic and organic soil components, soil solution-solid phase equilibria, sorption phenomena, ion exchange reactions, kinetics of soil chemical processes, redox chemistry, soil acidity and salinity.

**Policy**

**ENEP626: Climate Change: Science, Policies & Political Economy (3)**

- Examines existing policy responses to climate change, alongside opportunities for a redirected political economy to achieve energy and environmental conditions with meaningful CO<sub>2</sub> reductions. Specific attention given to possibilities and limits of scientific knowledge and technology in galvanizing social change.

**ENEP 666: Topics in Sustainable Development**

**ENEP 810: Political Economy of the Environment (3)**

- Reviews major theories developed over the last half century to explain nature-society relations. Policy case studies on environmental justice, trade and environment, global climate change, and sustainable development used to evaluate current range of political-economic explanations of nature-society relations. International, national and local responses to these problems are analyzed.

**ENEP 868: Sustainable Water Policy Research (1-6)**

**ENEP 870: Sustainable Water Policy Readings (3)**

**GEOG617: Seminar in Climate Change (3)**

- Examines facts and fallacies regarding global warming and climate science and assesses the current state of scientific understanding of and ability to forecast climate change.

GEOG649: Environment & Society (3)

- Considers the relationships between environmental and social processes from theoretical, philosophical, and methodological perspectives of geography. Explores the ethical and contextual implications implied in framing environmental questions and posing solutions. Examines approaches to the geographical analysis of environmental problems.

MAST/UAPP 663: Decision Tools for Policy Analysis (3)

- Develops quantitative decision-making skills for science and technology policy decisions. Covers decision-making under uncertainty, axioms of decision analysis, decision trees, influence diagrams, sensitivity analysis, confidence intervals, value of information, probabilistic risk assessment, and multi-attribute decision theory.

MAST672/ECON670: Applied Policy Analysis (3)

- Empirical analysis of environmental and natural resource policy issues. Topics include valuation of natural resources, decision making under uncertainty, dynamic control and intertemporal issues in resource use and institutional aspects of policy analysis.

MAST670: US Ocean and Coastal Policy (3)

- Provides an overview and assessment of the evolution of U.S. ocean and coastal policies, including such policy areas as coastal management, fisheries management, marine mammal protection, offshore oil development, and marine pollution control.

MAST/ECON 676: Environmental Economics (3)

- Study of the choice of policies to protect the environment, including land, air and water resources. Theory of market failure and externalities, use of economic incentives in policy design, valuation of environmental resources and examination of inefficiencies in existing U.S. environmental policies.

MAST/ECON 867: Valuing the Environment (3)

- The economic theory and empirical methods used for valuing environmental goods. Topics include welfare theory, contingent valuation, choice experiments and conjoint analysis, travel cost models, hedonic price analysis, defensive expenditure methods, and benefits transfer. The foundation for each method is developed along with contemporary readings on actual applications. Students must complete a 'valuation project' using empirical data.

POSC818: Environmental Politics and Policy (3)

- U.S. and international environmental politics, policies, laws, and agreements regarding air, water, and natural resource protection. Examines environmental governance regimes, politics and science, theories of environmental policy, public

and private interaction, and epistemic communities in global warming, ozone layer protection, and environmental public health.

**UAPP611: Regional Watershed Management (3)**

- Reviews the practical applications of watershed planning as a tool to manage land, water and ecosystem resources. Explores public policies and practices of watershed planning by examining case studies. Uses a multidisciplinary approach involving the fields of geography, environmental science, geology, public policy, land planning, geographic information systems (GIS) and engineering.

**UAPP/ENEP 617: Contemporary Issues in Environmental and Energy Policy (1)**

- Links students with leading energy and environmental policy scholars on a bi-weekly basis to debate key issues such as global warming, ozone layer deterioration, environmental justice, sustainable development and ecological democracy. International, national and community dimensions of these and other policy issues are explored through seminar discussion.

**UAPP628: Issues in Land Use and Environmental Planning (3)**

- Examines theory and contemporary practice in land use and environmental planning with emphasis on creating an integrative framework that balances development demands for urban, suburban, and agricultural land against the needs to conserve and enhance environmental and cultural resources.

**UAPP667: Field Seminar in Water Policy (3)**

- Using case studies from the Delaware River and Chesapeake Bay basins, students will examine the social, economic, legal, and policy aspects of water resources planning and management. This field seminar will include visits and field reconnaissance to watershed governance organizations in the Mid- Atlantic such as the Delaware River Basin Commission, Delaware Estuary Program, and Chesapeake Bay Program. Service-based learning is envisioned, in which students will be encouraged to collaborate with career watershed managers in the field while integrating the fundamentals of water policy through instruction in the classroom.

**Research Methods**

**PLSC667: Research Methods and Topics in Water Science & Policy (2)**

- Selected topics and field and laboratory methods to investigate the physical, chemical and biological aspects of water and the socioeconomic, policy, and regulatory issues associated with water.

**PLSC667: Interdisciplinary Seminar in Water Science & Policy (1)**

- Interdisciplinary seminar series highlighting important scientific and policy issues related to water.

## **Statistics, Analysis & Techniques**

### **CHEG604: Probability and Statistics for Engineering Problem Solving (3)**

- Fundamental approach to modeling, characterization and analysis of random phenomena with the objective of providing students with the basic principles, methods and tools for solving engineering problems involving randomly varying phenomena. Application areas explored include experimental design, manufacturing, system reliability, and cellular biology.

### **FREC/STAT608: Statistical Research Methods (3)**

- Experimental design and plot plans, collection, analysis and presentation of data in agricultural and biological research.

### **FREC615: Advanced Prices and Statistics (3)**

- Statistical tools used in agricultural economics research and operations research. Introduction to econometric specifications, estimation and interpretation.

### **FREC/STAT674: Applied Data Base Management (3)**

- Provides an in-depth understanding of using computers to manage data using programs such as SAS and Microsoft/Access.

### **FREC 807/ORES801**

- Explores the development and application of optimization models and methods such as linear programming, integer programming, non-linear programming, and goal programming. Applications to both firm and sector-level economic issues with a particular emphasis on agricultural, environmental, resource economic applications.

### **GEOG671: Advanced Geographic Information Systems (4)**

- Commercial geographical information systems (GIS) are introduced and used to analyze a wide variety of spatial databases. Georeferenced data are acquired, restructured and manipulated in a GIS environment. GIS methods are applied to local-scale geographical, environmental and land planning problems.

### **MAST681: Remote Sensing of the Environment (3)**

- Detection and mapping of land and ocean resources with optical, infrared and microwave sensors. Digital analysis of satellite images using multispectral and spatial analysis techniques and correlation with ground/ship data. Application to oceanography, coastal processes, geology, land use, geography, agriculture, climate and pollution studies. Includes hands-on image analysis in GIS laboratory.

### **MEEG690: Intermediate Engineering Mathematics (3)**

- Linear algebra: generalized vector space, eigenvalue problem, diagonalization, quadratic forms. Field theory: divergence theorem, Stokes' theorem, irrotational fields. Sturm-Liouville theory, Bessel functions, Legendre polynomials. Partial

differential equations: diffusion and Laplace equations by separation of variables and Sturm-Liouville theory, wave equation. Engineering applications.

STAT657: Statistics for Earth Sciences (3)

- Spatial distributions; directional data; statistical graphics, regression and time series analysis; model validation; sampling; principal components; cluster analysis; discriminant analysis; and statistical software routines. PREREQ: MATH201

STAT675: Logistic Regression (3)

- Practical and computational introduction to logistic regression and related topics. Applications include financial, marketing and biomedical research. The use of SAS and other statistical packages will be emphasized.

UAPP652: Geographic Information Systems in Public Policy (1)

- Hands-on introduction to Geographic Information Systems (GIS) and their uses in public policy areas. Content varies. Exercises focus on using geographic data in fields such as environmental analysis, land use planning, and socio-economic analysis.

UAPP691: Quantitative Analysis in Public & NP Sectors (3)

- Study of basic research design and data analysis techniques stressing applications in the public and nonprofit sectors. Includes research design, data acquisition, measurement, descriptive statistics, data collection, probability, exploratory data analysis, hypothesis testing, simple and multiple regression, correlation, and graphical procedures.

UAPP816: Advanced Social Statistics (3)

- Provides advanced training in applied social research. Topics include analysis of variance, regression analysis, analysis of covariance, multi-dimensional cross-classifications and future analysis. Lectures supplemented by laboratory work involving computer statistical packages and simulations.

## **XII. APPENDIX V — Selected Graduate Programs in Water Science & Policy at Other Institutions**

Texas A&M – Water Degree Program

<http://waterprogram.tamu.edu/>

University of Minnesota – Water Resources Science

<http://wrs.umn.edu/>

Oregon State University – Water Resources Graduate Program

<http://oregonstate.edu/gradwater/degreeprograms/wrs.php>

University of Colorado – Hydrologic Sciences Program

<http://hydrosciences.colorado.edu/about/index.php>

University of California at Davis – Hydrologic Sciences

<http://hydscigrad.ucdavis.edu/program/reqs.html>

University of Nevada - Reno & Las Vegas- Hydrologic Sciences

<http://www.hydro.unr.edu/home/>

<http://sciences.unlv.edu/wrm/>

**D. Graduate Program Policy Document.**



# **WATER SCIENCE AND POLICY**

## **GRADUATE PROGRAM POLICY STATEMENT**

### **(UPDATED – JANUARY 2014)**

## **I. PROGRAM HISTORY**

### **A. RATIONALE**

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are putting immense pressure on the supply and quality of our water resources. Addressing these complex challenges and finding solutions will require a comprehensive, integrated and interdisciplinary approach. Not only must society address the physical, chemical and biological aspects of these problems; society must also ensure that the proposed solutions are socially acceptable, economically viable, and environmentally sustainable. The National Science Foundation, National Academy of Sciences, Congressional Research Service, USGS, NOAA, and USEPA have all concluded that a new interdisciplinary education and research approach is needed that integrates science and policy to address society's emerging challenges in water sustainability. The interdisciplinary graduate program in Water Science and Policy at the University of Delaware is focused on these challenges by training students and professionals who can think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

The graduate program in Water Science and Policy reflects the strategic priorities at the University of Delaware, including an emphasis on environmental research and sustainability, the growing number of environmentally focused faculty, and the University's *Initiative for the Planet*, all within the University's *Path to Prominence*.

The vision is a university-wide graduate program that will attract students to many departments and colleges across the campus. The students will be located within individual departments and will work with individual advisors who are affiliated with the program. The students are required to meet the specific requirements of the program to be awarded the degree in Water Science & Policy.

The graduate program in Water Science & Policy is synergistic with other programs on campus, and draws entirely upon existing courses. All students in the Water Science & Policy program take a team-taught course, entitled "Research Methods and Topics in Water Science and Policy" that involves both field and lab experiences, as well as a companion one-credit seminar series.

The availability of high quality water to sustain human activities and ecosystem health is among the most critical global challenges of the 21<sup>st</sup> century, given pressures on water resources due to climate change, contaminants, population growth, hydropolitics, conservation issues and infrastructure challenges. Solutions to complex problems of water quantity and quality will require both scientific understanding and implementation through effective policy. Scientists, engineers and policy experts need to understand and predict the interactions of Earth's water system with climate change, land use, the built environment and ecosystem function and

services. They will need to determine how the built water systems and our governance systems can be made more reliable, resilient and sustainable in the face of diverse and often conflicting needs.

Despite its name, the Earth is a water planet. However, pressure on water resources is growing, increasing the need for understanding water availability, quality and dynamics. The impacts of climate change and human activity have created an urgent need for experts who bring both depth and breadth of experience, and a systemic perspective to the science and policy of water at the local, regional, national, and international scales.

The program in Water Science and Policy at the University of Delaware is designed to meet this increasing national and international demand for interdisciplinary water experts and to provide students with an educational opportunity that crosses traditional disciplinary and organizational boundaries. Due to the interdisciplinary nature of water sciences and policy, experts in these fields within the University of Delaware are housed in many Colleges and Departments and affiliated centers and institutes on campus; thus, the faculty affiliated with the program may be in one of several science, engineering or social science disciplines.

The Water Science & Policy program aims to train the next generation of researchers and professionals who will play key roles in protecting and managing a vital resource, and who will play a key role in multi- and interdisciplinary teams, bridging physical, chemical, biological and policy sciences. The program is administered through the College of Agriculture & Natural Resources, and the scientific curriculum builds upon the research and educational strengths of departments across the Colleges of Agriculture & Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering. Water Science & Policy is an essential 21<sup>st</sup> century environmental thrust in academia, industry, and government, and affects public policy decisions across the globe.

## **B. DEGREES OFFERED**

Three degree options are offered:

- 1) **PhD in Water Science & Policy, Water Science Concentration;**
- 2) **PhD in Water Science & Policy, Water Policy Concentration;** and
- 3) **Master of Science in Water Science & Policy.**

Doctoral students in the Water Science Concentration complete course requirements and carry out research that emphasizes science and engineering, but that provides exposure to policy tools and processes. Doctoral students in the Water Policy Concentration complete course requirements and carry out research that emphasizes economics and public policy, but that provides exposure to relevant science and engineering areas. Students in both Concentrations will have the opportunity to pursue directed research, a special problem, independent study or internship as part of required work.

The Master of Science option in Water Science and Policy prepares students to carry out advanced research at the doctoral level, or to take professional positions requiring graduate level preparation.

## II. ADMISSION

### A. ADMISSION REQUIREMENTS

Admission to graduate programs is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

To officially apply for admission, see <http://www.udel.edu/gradoffice/apply/> for detailed instructions, web-based forms, and contact information. To be admitted to the graduate program applicants should meet the following requirements:

1. A completed University of Delaware Graduate Studies application. In the application, prospective students should indicate clearly whether they are applying for the MS or the Ph.D. program (select the Water Science or the Water Policy concentration). Students may apply to the program prior to arranging for a faculty advisor; however, all students in the program will need a program faculty member to serve as advisor.
2. A personal statement is required in the Graduate Studies application, and should discuss the following questions:
  - a. What are your specific research and educational goals?
  - b. What are your long-term professional career objectives?
  - c. How do you see this program assisting you with achieving your objectives?
  - d. What is the name of the faculty member (affiliated with the program) who has agreed to be advisor?
3. Graduate Record Examination Scores are required (a minimum of 1050 (on the old scale) on the VERBAL and QUANTITATIVE is desirable; on the new scale a minimum of 50 percentile is desirable). Subject GRE scores are not required.
4. Official, up-to-date transcripts of all undergraduate and graduate programs. A minimum of 3.0/4.0 is required in the major.
5. Three letters of recommendation from individuals knowledgeable of the applicant's academic preparation and potential ability as a graduate student.
6. International students must take the Test of English as a Foreign Language (TOEFL) (Minimum Score: 550 paper test, 213 computer test or 79 on Internet-based tests.) TOEFL scores more than two years old cannot be considered official.

## **B. PRIOR DEGREE REQUIREMENTS**

Applicants for the Ph.D. program will typically have an M.S. degree in a related field. Direct admission to the Ph.D. program immediately after a B.S. degree will only be considered for exceptionally qualified candidates, as determined by the Program Committee. These candidates will, however, have to complete all the course requirements associated with the Water Science and Policy M.S. program prior to starting the Ph.D. curriculum. Prior graduate coursework (a maximum of 9 credit hours) will be considered toward Ph.D. course requirements, with the approval of the Program Committee.

## **CHANGE OF CLASSIFICATION AND TRANSFER STUDENTS**

Students that are currently matriculated in other degree programs should complete a “Change of Classification” Form to seek approval to be admitted into the Water Science and Policy Program. The Program Committee will evaluate the change in classification and transfer requests on a case-by case basis to determine if the applicant will need to complete a full application form submitted to the Office of Graduate and Professional Education. All transfer students will still have to meet the requirements listed above.

## **C. APPLICATION DEADLINES**

Admission decisions are made on a rolling basis as and when applications are complete. The application deadlines are:

- Fall Semester: July 1 ; February 1 for financial aid
- Spring Semester: December 1

## **D. SPECIAL COMPETENCIES NEEDED**

None.

## **E. ADMISSION CATEGORIES**

Students are accepted in the following degree programs:

- ☐ M.S.– Master of Science (thesis) in Water Science and Policy
- ☐ Ph.D.– Doctor of Philosophy in Water Science and Policy (Water Science concentration)
- ☐ Ph.D.– Doctor of Philosophy in Water Science and Policy (Water Policy concentration)

### *Part-time students*

In some circumstances it is possible to pursue a degree on a part-time basis.

### *Provisionally-accepted students*

Full and part time students may be admitted to the program with provisional status if there are deficiencies in their academic backgrounds, as determined by the Admissions Committee.

Deficiencies typically include an inadequate academic background, particularly a lack of appropriate course work in the major area and are usually remedied by satisfactory performance in a course(s) in

the deficient area. A letter of provisional admission will indicate specific area(s) of academic deficiency, and the time limits for satisfactory completion of course(s) needed to make up deficiencies. Satisfactory completion of the stipulations in the letter of provisional admission will result in a change of status from provisional to regular student status. The student's advisor and the Program Director will inform the student and the Office of Graduate and Professional Studies of the change in status. Students who do not complete the remedial training in the stipulated time may be expelled from the program.

#### **F. OTHER DOCUMENTS REQUIRED**

None.

### III. ACADEMIC PROCEDURES

#### A. DEGREE REQUIREMENTS

##### 1. COURSE REQUIREMENTS SUMMARY

###### a. PhD Program Requirements: Water Science & Policy

<b>PhD in Water Science &amp; Policy (36 Credits)</b>		
Course Areas	Water Science Concentration	Water Policy Concentration
Water Science	9 Credits	3 Credits
Water Policy	3 Credits	9 Credits
Research Methods	3 Credits	3 Credits
Statistics, Analysis & Techniques	3 Credits	3 Credits
Directed Research/Special Problem/Internship/Independent Study	9 Credits	9 Credits
Dissertation	9 Credits	9 Credits

###### b. Master of Science Program Requirements: Water Science & Policy

<b>MS in Water Science &amp; Policy (30 Credits)</b>	
Credit Hours Total	
Water Science, Policy, Research Methods, Statistics & Analysis	24 Credits
Thesis	6 Credits

##### 2. CURRICULUM

The tables below list the course curriculum for the major components of the graduate program in Water Science & Policy. Some courses may be offered at both the 400- and 600- levels. A student who has completed a course at the 400-level may not take the same course at the 600-level for credit toward the graduate degree.

**Table 1. PhD Program Requirements: Water Science & Policy**

<b>PhD in Water Science &amp; Policy (36 Credits)</b>		
Course Areas	Water Science Concentration	Water Policy Concentration
Water Science	9 Credits	3 Credits
Water Policy	3 Credits	9 Credits
Research Methods	3 Credits	3 Credits
Statistics, Analysis & Techniques	3 Credits	3 Credits
Directed Rsch/Special Prob./Internship/Independent Study	9 Credits	9 Credits
Dissertation	9 Credits	9 Credits
<b>Science Courses</b>  <b>Water Science Concentr. Students (9)</b> [Select at least 3 credits from each category.]  <b>Water Policy Concentr. Students (3)</b> [Select one course from physical or chemical/biological science.]	<b>a) Physical Sciences</b>	
	BREG 623 Advanced Storm water Management	
	CIEG 698 Groundwater Flow and Contaminant Transport	
	GEOG 632 Environmental Hydrology	
	GEOG 656 Hydroclimatology	
	GEOG 651 Microclimatology (4)	
	GEOL 628 Hydrogeology	
	GEOL 611 Fluvial Geomorphology	
	PLSC 603 Soil Physics	
	<b>b) Chemical/Biological Sciences</b>	
	BREG 621 Nonpoint source pollution	
	BREG 667 Watershed Hydrochemistry	
	CHEM/MAST 683 Environmental Chemistry	
	CIEG 632 Chemical Aspects of Environmental Engineering	
	CIEG 636 Biological aspects of Environmental Engineering	
	CIEG 668 Principles of Water Quality Criteria	
	GEOG 631 Watershed Ecology	
	GEOG 667 Watershed Hydro-Ecology	
	PLSC 608/CHEM 608 Environmental Soil Chemistry	
	MAST 618 Marine Microbial Ecology	
	<b>c) Policy</b>	
	ENEP 626 Climate Change: Science, Policy and Political Economy	
	ENEP 666 Topics in Sustainable Development	
	ENEP 810 Political Economy of the Environment	
	ENEP 868 Sustainable Water Policy Research	
	ENEP 870 Sustainable Water Policy Readings	
	GEOG 617 Seminar in Climate Change	
	GEOG 649 Environment & Society	
	MAST 672/ECON 670 Applied Policy Analysis	
	MAST/ECON 867 Valuing the Environment	
	MAST 670 US Ocean and Coastal Policy	
	MAST 670 Legal Aspects of the Coastal Zone	
	MAST/ECON 676 Environmental Economics	
	MAST/UAPP 663 Decision Tools for Policy Analysis	
	POSC 818 Environmental Politics and Policy	
	UAPP 611 Regional Watershed Management	
	UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)	
	UAPP 628 Issues in Land Use and Environmental Planning	
	UAPP Environmental Policy Analysis	
	UAPP 667 Field Seminar in Water Policy	
<b>Research Methods Courses (3)</b>	<b>d) Research Methods</b>	
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)	
	PLSC 667 Interdisciplinary Seminar (1)	
	CIEG 667 Research in Water Science and Policy (1)	
<b>Statistics, Analysis &amp; Techniques (3)</b> [Select three credits from the category Statistics, Analysis & Techniques]	<b>e) Statistics, Analysis &amp; Techniques:</b>	
	CHEG 604 Probability and Statistics for Engineering Problem Solving	
	FREC/STAT 608 Statistical Research Methods	
	FREC 615 Advanced Prices and Statistics	
	FREC/STAT 674 Applied Database Management	
	FREC 807 Mathematical Programming with Economic Applications	
	GEOG 671 Advanced Geographic Information Systems	
	MAST 681 Remote Sensing of Environment	
	MEEG 690 Intermediate Engineering Mathematics	
	STAT 657 Statistics for Earth Sciences	

	STAT 675 Logistic Regression
	UAPP 816 Advanced Social Statistics
	UAPP 691 Quantitative Analysis in Public & NP Sectors
	UAPP 652 Geographic Information Systems in Public Policy (1)
<b>Directed Research/Special Problem/Internship/Independent Study (9)</b>	
<b>Dissertation (9)</b>	

**Table 2. M.S. Requirements**

<b>MS in Water Science &amp; Policy – Course Curriculum (30 credits)</b>	
<b>Select 24 credits, with at least 3 credits from each category.</b>	<b>a) Physical Sciences</b>
	BREG 623 Advanced Storm water Management
	CIEG 698 Groundwater Flow and Contaminant Transport
	GEOG 632 Environmental Hydrology
	GEOG 656 Hydroclimatology
	GEOG 651 Microclimatology (4)
	GEOL 628 Hydrogeology
	GEOL 611 Fluvial Geomorphology
	PLSC 603 Soil Physics
	<b>b) Chemical/Biological Sciences</b>
	BREG 621 Nonpoint source pollution
	BREG 667 Watershed Hydrochemistry
	CHEM/MAST 683 Environmental Chemistry
	CIEG 632 Chemical Aspects of Environmental Engineering
	CIEG 636 Biological aspects of Environmental Engineering
	CIEG 668 Principles of Water Quality Criteria
	GEOG 631 Watershed Ecology
	GEOG 667 Watershed Hydro-Ecology
	PLSC 608/CHEM 608 Environmental Soil Chemistry
	MAST 618 Marine Microbial Ecology
	<b>c) Policy</b>
	ENEP 626 Climate Change: Science, Policy and Political Economy
	ENEP 666 Topics in Sustainable Development
	ENEP 810 Political Economy of the Environment
	ENEP 868 Sustainable Water Policy Research
	ENEP 870 Sustainable Water Policy Readings
	GEOG 617 Seminar in Climate Change
	GEOG 649 Environment & Society
	MAST 672/ECON 670 Applied Policy Analysis
	MAST/ECON 867 Valuing the Environment
	MAST 670 US Ocean and Coastal Policy
	MAST 670 Legal Aspects of the Coastal Zone
	MAST/ECON 676 Environmental Economics
	MAST/UAPP 663 Decision Tools for Policy Analysis
	POSC 818 Environmental Politics and Policy
	UAPP 611 Regional Watershed Management
	UAPP/ENEP 617 Contemp. Issues in Environmental and Energy Policy (1)
	UAPP 628 Issues in Land Use and Environmental Planning
	UAPP 667 Field Seminar in Water Policy
	UAPP Environmental Policy Analysis
	<b>d) Research Methods</b>
	PLSC 667 Research Methods and Topics in Water Science & Policy (2)
	PLSC 667 Interdisciplinary Seminar (1)
	CIEG 667 Research in Water Science and Policy (1)
	<b>e) Statistics, Analysis &amp; Techniques:</b>
	CHEG 604 Probability and Statistics for Engineering Problem Solving
	FREC/STAT 608 Statistical Research Methods
	FREC 615 Advanced Prices and Statistics



	FREC/STAT 674 Applied Database Management
	FREC 807 Mathematical Programming with Economic Applications
	GEOG 670 Geographic Information Systems and Science
	GEOG 671 Advanced Geographic Information Systems
	MAST 681 Remote Sensing of Environment
	MEEG 690 Intermediate Engineering Mathematics
	STAT 657 Statistics for Earth Sciences
<b>Directed Research Option (3)</b> With advisor approval, MS students may opt to carry out directed research, in lieu of one course, within categories a, b, or c above.	
<b>Thesis (6)</b>	

### **3. GRADE MINIMUMS**

See University policy.

### **4. COURSES INELIGIBLE TOWARDS DEGREE**

Registration as a listener (L) or enrollment in undergraduate-level courses will not apply toward the degree. Course work which is not previously approved may be judged unacceptable by the graduate advisory committee and, therefore, should be discussed with committee members when registering.

### **5. ENGLISH COMPETENCY**

Students are expected to communicate effectively in written and oral English, including the ability to concisely present their data and compose a manuscript or research proposal. This will be assessed by the advisor and graduate committee and, more formally, during seminar presentations.

## **B. COMMITTEES FOR EXAMS, THESIS, OR DISSERTATIONS**

### **1. INITIAL PROCEDURES FOR ADVISOR/STUDENT**

Ideally, students may contact advisors directly to pursue study in their laboratories. Advisors can also examine the applicant pool to select students whom they are interested in advising.

### **2. PROCEDURE FOR SELECTING COMMITTEE MEMBERS**

The major advisor and student should discuss potential committee members who might provide support for the student's research. It is the responsibility of the graduate student to ask each committee member if they are willing to serve.

Requirements for the composition of advisory committees are:

**M.S.** Minimum of three members, including -

- advisor
- at least one additional faculty member affiliated with the Water Science and Policy program who should be from the area of concentration other than that of the student

**Ph.D.** Minimum of four members, including -

- advisor
- at least two faculty members affiliated with the Water Science and Policy program
- at least one committee member must be external to the program or from outside the University

### **3. DEADLINES**

Establishment

For a MS student, the committee should be established within the first year after being admitted to the program. For a PhD student, the committee should be established within 1.5 years of joining the program. Coincident with its establishment, it is the responsibility of the student to notify the Program Director in writing of the committee members and their affiliations.

### Meetings

- Graduate committees must meet at least once each year and meetings every 6 months are recommended. It is the responsibility of the student to organize the meetings.
- Responsibilities of committee members include the following:
  - Work with student to develop a program of study
  - Review research proposal defense and provide recommendations
  - Ensure acquisition of skills (competence in certain laboratory, greenhouse, and/or field research techniques is essential for completion of an acceptable thesis or dissertation) are developed
  - Serve as advisory body during period of candidacy
  - Administer written and oral qualifying examinations to Ph.D. candidates
  - Establish the contribution of the thesis or dissertation to chosen area of expertise and determine the degree of scholarship attained by the student

## **4. EXAMINATION AND GRADING POLICIES**

Ph.D. candidates must have at least one year between their qualifying exam and their defense. Formal grading of committee examinations will be at the discretion of the student's graduate committee.

## **5. GUIDELINES FOR RESEARCH PROPOSAL INVOLVING HUMAN AND ANIMAL SUBJECTS**

Students must attend human or animal subjects training and request approval from the human or animal subject committee at the University. Proposals that include interviews, case studies, or other interrogative methodologies must have all questions approved by the University Human Subjects Review Board.

## **6. PROCEDURES FOR THESIS/DISSERTATION APPROVAL**

Admission to candidacy for the Ph.D. degree, and acceptance of the M.S. thesis or Ph.D. dissertation in partial fulfillment of the degree requirements, will be recommended if no more than a single dissenting vote is cast by the graduate committee.

## **7. PROCEDURES FOR CHANGES IN COMMITTEE MEMBERS**

Changes are to be coordinated by advisor and student when necessary.

## **C. SATISFACTORY PROGRESS**

### **1. ACADEMIC LOAD**

Full-time students are expected to complete the MS program (30 credits) within two years. The program may be completed over a longer time frame for part-time students. Students in the Ph.D. program (36 credits) will typically complete the program in four to six years.

Students enrolled in at least 9 credit hours or in sustaining credit are considered full-time students. Those enrolled for fewer than 9 credit hours are considered part-time students, although students holding assistantships are considered full-time with six credits. Generally, a maximum load is 12 graduate credit hours; however, additional credit hours may be taken with the approval of the student's adviser and the Office of Graduate and Professional Education. A maximum course load in either summer or winter session is 7 credit hours. Permission must be obtained from the Office of Graduate and Professional Education to carry an overload in any session

## **2. TRANSFERABILITY**

Previous graduate level courses (a maximum of 9 credit hours) will be considered toward completion of Ph.D. course requirements, subject to approval by the Program Committee.

## **3. GRADE REQUIREMENTS**

Only graduate courses completed with a grade of B- or higher count towards the requirements of the MS and PhD program in Water Sciences and Policy. Graduate students receiving financial assistance must maintain a 3.0 overall GPA. If a student's GPA should fall below this level, loss of stipend is possible. A one-semester grace period may be provided in which the student has the opportunity to improve his/her GPA. However, the grace period is not automatic and requires approval that is initiated by a written request from the faculty advisor to the Program Director and the Office of Graduate and Professional Studies. A student's stipend may be reinstated, if lost for academic or other reasons, only after approval by the Program Committee and the Director. Any graduate student, self-supporting or those receiving financial assistance, with a GPA less than 3.0, is subject to a reclassification of academic status to warning, probation, or termination depending upon the severity of the substandard academic performance. Details are provided in the University Graduate Catalog. It is the responsibility of the faculty advisor to inform the student committee and Program Director of substandard academic performance.

## **4. MASTER'S DEGREE REQUIREMENTS**

The development of a program of study will be the joint responsibility of the student in consultation with the major advisor. The student will select a minimum of three-person thesis committee that includes the student's major advisor and at least one other member from the Water Science and Policy program. The thesis committee needs to be established within one year in the program. The names of the selected thesis committee members should be forwarded to the Program Director by the student.

M.S. Thesis students must complete 24 credit hours of course work and 6 credit hours of thesis (a total of 30 credits). Specific course requirements for the M.S. in Water Science

and Policy are described above in Section on Course Curriculum. All full-time MS students are required to complete the degree requirements in six semesters or fewer. Students are expected to write and successfully defend the thesis to receive the degree.

Advancement to degree candidacy is contingent upon successful completion and presentation of the thesis proposal. The thesis proposal should be presented to the Thesis Committee for approval within 1.5 years in the program. The completed thesis will be presented to the Thesis Committee in typewritten form at least two weeks before the scheduled oral defense. The oral defense of the student thesis will be publicly announced and all program members will be notified at least one week prior to the defense date.

The maximum time for the completion of the MS program is 5 years from the time of entry.

## **5. PH.D. REQUIREMENTS**

The development of a program of study will be the joint responsibility of the student in consultation with the graduate advisor. The student will select a minimum of four-person Dissertation Committee that includes the student's major advisor and at least two other faculty members from the Water Science and Policy program. The Dissertation Committee needs to be established within 1.5 years of study in the program. The names of the Committee members should be submitted to the Program Committee for approval.

Ph.D. students must complete 18 credit hours of course work, plus 9 credit hours of research, and 9 credit hours of thesis (a total of 36 credits). Specific course requirements for the Water Science and the Water Policy concentrations are described above in Section on Course Curriculum. Students must maintain a minimum of 3.0 cumulative GPA in order to receive the degree. Course with a grade below a B- will not be counted towards the degree. The program of study must be submitted before the end of the first year to the graduate advisor for approval. Previous graduate-level coursework will be considered toward Ph.D. course requirements, subject to the approval of the Program Committee.

The PhD qualifying exam should be taken within 2.5 years of study in the program. The qualifying examination will include written and oral portions. The student's graduate advisor will chair and administer the exam and the content of the exam (written and oral) will be decided jointly by the student's Dissertation Committee. The exam will be graded by the Dissertation Committee and each member of the committee will provide a single grade (including written and oral sections) of PASS or FAIL. A student can only take the exam a maximum of two times. A failure in two attempts will result in dismissal from the PhD program.

The student must submit a research proposal prior to initiating dissertation research. A pre-proposal should be prepared within the first year and should be shared with the Dissertation Committee. A formal proposal should be presented and defended by the student no later than six months from the completion of the written qualifying exam. The proposal defense and oral qualifying examination can be combined.

Upon successful completion of the qualifying exam and the proposal defense, the student is certified as a candidate for the doctoral degree. The graduate advisor will notify the Program Committee on the result of the qualifying exam. A copy of the student's PhD proposal will also be placed in the program records.

Upon the recommendation of the Dissertation Committee the student may be admitted to candidacy for the Ph.D. degree. The stipulations for admission to doctoral candidacy are that the student has (1) had a program of study approved, (2) completed one academic year of full-time graduate study in residence at the University, (3) passed the program's qualifying examination, (4) demonstrated the ability to do research, and (5) had a research project accepted by the Dissertation Committee.

The final examination of the PhD degree will involve approval of the written dissertation and an oral defense of the candidate's dissertation. The written dissertation will be submitted to the Dissertation Committee and the Water Science & Policy Program office at least three weeks in advance of the oral defense date. The oral defense date will be publicly announced at least two weeks prior to the scheduled date. The oral presentation will be open to the public and all members of the Water Science and Policy program. The Dissertation Committee will approve the candidate's dissertation. The student and graduate advisor will be responsible for making all corrections to the dissertation document and for meeting all Graduate School deadlines for submission.

The maximum time for the completion of the PhD program is 10 years from the time of entry.

## **6. STANDARDS OF STUDENT CONDUCT**

All graduate students are subject to University of Delaware regulations regarding academic honesty. Violations of the UD regulations regarding academic honesty or other forms of gross misconduct may result in immediate dismissal from the Program.

## **7. DISMISSAL**

The procedures for dismissal as detailed in the University Catalog will be followed. Briefly, the Graduate Committee will report its recommendation and reason for dismissal to the Director of the Water Science and Policy program. The Director will make a recommendation to the Office of Graduate Studies, who will decide whether to dismiss the student. The student may appeal this decision to the Office of Graduate Studies, following the procedure given in the University Catalog.

## **8. GRADUATE STUDENT GRIEVANCE PROCEDURES**

Students who feel that they have been graded inappropriately or receive what they perceive as an unfair evaluation by a faculty member may file grievances in accordance with University of Delaware policies. Students are encouraged to contact the Director of the graduate program in Water Science & Policy prior to filing a formal grievance in an effort to resolve the situation informally.

## **9. ATTENDANCE AT CONFERENCES AND PROFESSIONAL MEETINGS**

The Water Science & Policy program encourages students to attend conferences and professional meetings. They provide opportunities to meet future employers and colleagues, and can offer specialized training beyond course work.

## IV. FINANCIAL AID

### A. FINANCIAL AWARDS

Admission to the graduate program in Water Science & Policy does not automatically entitle an applicant to financial aid. Students may seek financial aid opportunities, such as fellowships or scholarships from sources within the University and from private and federal agencies. Interested students should check the Office of Graduate Studies website for the most current opportunities.

Financial aid is awarded on a competitive basis from the pool of admitted applicants. The University of Delaware's policies apply to all forms of financial aid. Please refer to the University Policies for Graduate Student Assistantships and Fellowships.

Students in the Water Science and Policy program may apply for Graduate Assistantships:

**Research Assistantships (RAs)** are generally funded by research grants and contracts provided by external funding agencies. Students may be supported as an RA through their Faculty Advisor's research funds after their first year. A research assistantship provides full tuition and a stipend. The RA's advisor is responsible for defining the student's responsibilities and for evaluating the student's performance. The amount of service or research may vary from week to week but the average is usually expected to be 20 hours per week.

**Teaching Assistantships (TAs)** are offered for graduate students to perform teaching and other instructional activities by individual departments. The amount of service may vary from week to week but the average is usually expected to be 20 hours per week. A teaching assistantship provides full tuition and a stipend. Award of TA will be decided by the primary advisor and their department.

Preference for graduate student stipends will be given to students in the PhD Program. Students receiving full stipends will be expected to work 20 hours per week on faculty projects and students are expected to maintain full-time status.

### B. CONTINUATION OF FINANCIAL AID

Students who are awarded financial aid must maintain satisfactory academic progress with satisfactory performance of assistantship duties (when applicable). Satisfactory academic progress includes registering for a minimum of 9 graduate-level credits each Fall and Spring semester, and maintaining a minimum cumulative 3.0 GPA.

The Faculty Advisor will establish the RA's responsibilities and performance standards. In the event of an unsatisfactory performance by an RA, the advisor will notify the student and the Program Committee at least four weeks prior to terminating the assistantship.



The Director of the course in which the student teaches will establish the TA's responsibilities and performance standards. In the event of an unsatisfactory performance by a TA, the Course Director will notify the student and the Program Committee of the academic department offering the course. The Committee may recommend termination of the assistantship to the Department Chair.

## Appendix I – Course Descriptions

### Physical

#### BREG623: Advanced Storm Water Management (3)

- Design of gutters, storm drain inlets, and storm drains. Design of distributed and low impact development storm-water management systems. Erosion and sediment control for site development, flood plain hydraulics and analysis.

#### CIEG698: Groundwater Flow and Contaminant Transport (3)

- Development and application of models for fluid flow and contaminant transport in porous media. Derivation of governing equations, analytical and numerical solutions, and application to the movement of groundwater and transport of contaminants at an actual field site.

#### GEOG632: Environmental Hydrology (3)

- Introduction to hydrologic science. Topics include precipitation, snowmelt, evapotranspiration, infiltration, groundwater, runoff, streamflow, water resources management, and hydrologic applications of remote sensing and geographic information systems. Case studies illustrate hydrological response to changes in land use and climate. Group studies include field measurements and computer simulations.

#### GEOG651: Microclimatology (4)

- Introduction to instrumentation and techniques involved in microclimatic monitoring and sampling. Field observation carried out in varying environmental situations.

#### GEOG656: Hydroclimatology (3)

- Study of the hydrologic cycle as it relates to water in the atmosphere and in and on the earth's surface. Hydrologic processes including precipitation, soil moisture, evapotranspiration, runoff and streamflow will be examined.

#### GEOL611: Fluvial Geomorphology (3)

- Hydrologic and sediment transport processes in rivers and watersheds. Morphology and evolution of rivers and watersheds. Depositional processes and evolution of floodplains. Structure and interpretation of fluvial deposits in the geologic record.

#### GEOL628: Hydrogeology (3)

- Principles of groundwater flow and water chemistry in varied geologic media. Evaluation of groundwater resources and assessment of environmental problems associated with groundwater use.

### PLSC603: Soil Physics (3)

- Examines the importance of soil physics in relation to other disciplines of soil and environmental sciences. Topics include status of water in soil, fundamental principles of water flow, differences between saturated and unsaturated water flow, water balance in the field, infiltration, evapotranspiration, heat, gas and solute (contaminant) transport in soil.

### **Chemical/Biological**

### BREG421/621: Nonpoint Source Pollution (3)

- Understanding sources, transport pathways, and transformations of important pollutants and toxic chemicals generated by anthropogenic activities. Topics include transport, transformation, and fate of these pollutants in watersheds. Impacts of these pollutants on soil, forest, and aquatic ecosystems using specific case studies.

### BREG 667: Watershed Hydrochemistry (3)

- The role of hydrology in the exports of solutes and chemicals from watersheds. Linkages and feedbacks between hydrologic and biogeochemical processes. Mechanistic conceptual models for solute transport will be emphasized. Innovative methods to characterize and quantify solutes in watersheds will be discussed.

### CHEM/MAST683: Environmental Chemistry (3)

- Reactions in gas, liquid and solid phases of the Earth's atmosphere, hydrosphere, and geosphere, and energy fluxes and chemical exchanges across these interfaces discussed in the context of basic chemical principles. Applications to current issues such as climate change and air/water pollution discussed.

### CIEG632: Chemical Aspects of Environmental Engineering (3)

- The principles and applications of aqueous chemistry to environmental systems. Includes a review of general chemistry, with emphasis on the structure of matter and stoichiometry; chemical thermodynamics; chemical kinetics; equilibrium reactions in homogeneous and heterogeneous solutions; applied electrochemistry and Redox reaction; and interfacial phenomena.

### CIEG636: Biological Aspects of Environmental Engineering (3)

- Presents fundamental molecular biological concepts that pertain to cellular function in the environment and in engineered environmental treatment systems. Briefly reviews elementary organic chemical classifications.

### CIEG668: Principles of Water Quality Criteria (3)

- Toxicological and chemical background and technical basis necessary for understanding the models of water and sediment quality criteria for individual and mixtures of organic chemicals and metals that focus on bioavailability: narcosis

models of toxicity, complexation models applied to both the water column and sediments.

**GEOG631: Watershed Ecology (3)**

- Examines key biogeochemical processes and functional ecology of wooded ecosystems. Emphasis on examination of peer-reviewed scientific literature. Topics include inter- and intrasystem transport of nutrients and effects of abiotic stressors and animals on catchment scale nutrient budgets.

**GEOG667: Watershed Hydro-Ecology (3)**

- Examines linkages between hydrology and ecosystem processes in primarily human impacted watersheds. Addresses both terrestrial and aquatic ecosystems. Particular emphasis on effect of land use and climate change, and adaptive management practices.

**PLSC/CHEM608: Environmental Soil Chemistry (3)**

- Principles of soil chemical reactions and their application to environment including: inorganic and organic soil components, soil solution-solid phase equilibria, sorption phenomena, ion exchange reactions, kinetics of soil chemical processes, redox chemistry, soil acidity and salinity.

**MAST 618: Marine Microbial Ecology (3)**

**Policy**

**ENEP626: Climate Change: Science, Policies & Political Economy (3)**

- Examines existing policy responses to climate change, alongside opportunities for a redirected political economy to achieve energy and environmental conditions with meaningful CO<sub>2</sub> reductions. Specific attention given to possibilities and limits of scientific knowledge and technology in galvanizing social change.

**ENEP 666: Topics in Sustainable Development**

**ENEP 810: Political Economy of the Environment (3)**

- Reviews major theories developed over the last half century to explain nature-society relations. Policy case studies on environmental justice, trade and environment, global climate change, and sustainable development used to evaluate current range of political-economic explanations of nature-society relations. International, national and local responses to these problems are analyzed.

**ENEP 868: Sustainable Water Policy Research (1-6)**

**ENEP 870: Sustainable Water Policy Readings (3)**

GEOG 617: Seminar in Climate Change (3)

- Examines facts and fallacies regarding global warming and climate science and assesses the current state of scientific understanding of and ability to forecast climate change.

GEOG 649: Environment & Society (3)

- Considers the relationships between environmental and social processes from theoretical, philosophical, and methodological perspectives of geography. Explores the ethical and contextual implications implied in framing environmental questions and posing solutions. Examines approaches to the geographical analysis of environmental problems.

MAST/UAPP 663: Decision Tools for Policy Analysis (3)

- Develops quantitative decision-making skills for science and technology policy decisions. Covers decision-making under uncertainty, axioms of decision analysis, decision trees, influence diagrams, sensitivity analysis, confidence intervals, value of information, probabilistic risk assessment, and multi-attribute decision theory.

MAST 672/ECON 670: Applied Policy Analysis (3)

- Empirical analysis of environmental and natural resource policy issues. Topics include valuation of natural resources, decision making under uncertainty, dynamic control and intertemporal issues in resource use and institutional aspects of policy analysis.

MAST 670: US Ocean and Coastal Policy (3)

- Provides an overview and assessment of the evolution of U.S. ocean and coastal policies, including such policy areas as coastal management, fisheries management, marine mammal protection, offshore oil development, and marine pollution control.

MAST 674 Legal Aspects of the Coastal Zone (3)

- Examines basic legal doctrines and public policy implications relevant to the development and protection of the coastal zone of the United States. Use, ownership and control of water and land beneath and bordering upon water; relationships between the states and the federal government in areas of marine affairs; environmental protection and legal controls of water pollution.

MAST/ECON 676: Environmental Economics (3)

- Study of the choice of policies to protect the environment, including land, air and water resources. Theory of market failure and externalities, use of economic incentives in policy design, valuation of environmental resources and examination of inefficiencies in existing U.S. environmental policies.

MAST/ECON 867: Valuing the Environment (3)

- The economic theory and empirical methods used for valuing environmental goods. Topics include welfare theory, contingent valuation, choice experiments and conjoint analysis, travel cost models, hedonic price analysis, defensive expenditure methods, and benefits transfer. The foundation for each method is developed along with contemporary readings on actual applications. Students must complete a 'valuation project' using empirical data.

POSC 818: Environmental Politics and Policy (3)

- U.S. and international environmental politics, policies, laws, and agreements regarding air, water, and natural resource protection. Examines environmental governance regimes, politics and science, theories of environmental policy, public and private interaction, and epistemic communities in global warming, ozone layer protection, and environmental public health.

UAPP 611: Regional Watershed Management (3)

- Reviews the practical applications of watershed planning as a tool to manage land, water and ecosystem resources. Explores public policies and practices of watershed planning by examining case studies. Uses a multidisciplinary approach involving the fields of geography, environmental science, geology, public policy, land planning, geographic information systems (GIS) and engineering.

UAPP/ENEP 617: Contemporary Issues in Environmental and Energy Policy (1)

- Links students with leading energy and environmental policy scholars on a bi-weekly basis to debate key issues such as global warming, ozone layer deterioration, environmental justice, sustainable development and ecological democracy. International, national and community dimensions of these and other policy issues are explored through seminar discussion.

UAPP 628: Issues in Land Use and Environmental Planning (3)

- Examines theory and contemporary practice in land use and environmental planning with emphasis on creating an integrative framework that balances development demands for urban, suburban, and agricultural land against the needs to conserve and enhance environmental and cultural resources.

UAPP 667: Field Seminar in Water Policy (3)

- Using case studies from the Delaware River and Chesapeake Bay basins, students will examine the social, economic, legal, and policy aspects of water resources planning and management. This field seminar will include visits and field reconnaissance to watershed governance organizations in the Mid- Atlantic such as the Delaware River Basin Commission, Delaware Estuary Program, and Chesapeake Bay Program. Service-based learning is envisioned, in which students will be encouraged to collaborate with career watershed managers in the field while integrating the fundamentals of water policy through instruction in the classroom.

UAPP 667: Environmental Policy Analysis (3)

## **Research Methods**

PLSC 667: Research Methods and Topics in Water Science & Policy (2)

- Selected topics and field and laboratory methods to investigate the physical, chemical and biological aspects of water and the socioeconomic, policy, and regulatory issues associated with water.

PLSC 667: Interdisciplinary Seminar in Water Science & Policy (1)

- Interdisciplinary seminar series highlighting important scientific and policy issues related to water.

CIEG 667: Research in Water Science and Policy (1)

## **Statistics, Analysis & Techniques**

### **CHEG 604: Probability and Statistics for Engineering Problem Solving (3)**

- Fundamental approach to modeling, characterization and analysis of random phenomena with the objective of providing students with the basic principles, methods and tools for solving engineering problems involving randomly varying phenomena. Application areas explored include experimental design, manufacturing, system reliability, and cellular biology.

### **FREC/STAT 608: Statistical Research Methods (3)**

- Experimental design and plot plans, collection, analysis and presentation of data in agricultural and biological research.

### **FREC 615: Advanced Prices and Statistics (3)**

- Statistical tools used in agricultural economics research and operations research. Introduction to econometric specifications, estimation and interpretation.

### **FREC/STAT 674: Applied Data Base Management (3)**

- Provides an in-depth understanding of using computers to manage data using programs such as SAS and Microsoft/Access.

### **FREC 807/ORES801**

- Explores the development and application of optimization models and methods such as linear programming, integer programming, non-linear programming, and goal programming. Applications to both firm and sector-level economic issues with a particular emphasis on agricultural, environmental, resource economic applications.

### **GEOG 670 Geographic Information Systems and Science (3)**

- Introduces the principles and concepts of geographic information science to effectively use a professional level geographic information system. Practical hands-on exposure to "real" data and GIS software and hardware is provided through exercises and a final project.

### **GEOG 671: Advanced Geographic Information Systems (4)**

- Commercial geographical information systems (GIS) are introduced and used to analyze a wide variety of spatial databases. Georeferenced data are acquired, restructured and manipulated in a GIS environment. GIS methods are applied to local-scale geographical, environmental and land planning problems.

### **MAST 681: Remote Sensing of the Environment (3)**

- Detection and mapping of land and ocean resources with optical, infrared and microwave sensors. Digital analysis of satellite images using multispectral and spatial analysis techniques and correlation with ground/ship data. Application to oceanography, coastal processes, geology, land use, geography, agriculture, climate and pollution studies. Includes hands-on image analysis in GIS laboratory.



MEEG 690: Intermediate Engineering Mathematics (3)

- Linear algebra: generalized vector space, eigenvalue problem, diagonalization, quadratic forms. Field theory: divergence theorem, Stokes' theorem, irrotational fields. Sturm-Liouville theory, Bessel functions, Legendre polynomials. Partial differential equations: diffusion and Laplace equations by separation of variables and Sturm-Liouville theory, wave equation. Engineering applications.

STAT 657: Statistics for Earth Sciences (3)

- Spatial distributions; directional data; statistical graphics, regression and time series analysis; model validation; sampling; principal components; cluster analysis; discriminant analysis; and statistical software routines. PREREQ: MATH201

STAT 675: Logistic Regression (3)

- Practical and computational introduction to logistic regression and related topics. Applications include financial, marketing and biomedical research. The use of SAS and other statistical packages will be emphasized.

UAPP 652: Geographic Information Systems in Public Policy (1)

- Hands-on introduction to Geographic Information Systems (GIS) and their uses in public policy areas. Content varies. Exercises focus on using geographic data in fields such as environmental analysis, land use planning, and socio-economic analysis.

UAPP 691: Quantitative Analysis in Public & NP Sectors (3)

- Study of basic research design and data analysis techniques stressing applications in the public and nonprofit sectors. Includes research design, data acquisition, measurement, descriptive statistics, data collection, probability, exploratory data analysis, hypothesis testing, simple and multiple regression, correlation, and graphical procedures.

UAPP 816: Advanced Social Statistics (3)

- Provides advanced training in applied social research. Topics include analysis of variance, regression analysis, analysis of covariance, multi-dimensional cross-classifications and future analysis. Lectures supplemented by laboratory work involving computer statistical packages and simulations.

**E. Assessment of library resources available to support the graduate program as provided by the UD Library.**



University of Delaware Library

OFFICE OF THE INTERIM VICE PROVOST  
& DIRECTOR OF LIBRARIES

181 South College Avenue  
Newark, DE 19717-5267  
Phone: 302-831-2231  
Fax: 302-831-1046

October 27, 2015

Memorandum

To: Shreeram Inamdar  
Professor of Watershed Hydrology and Biogeochemistry  
Director, Water Science and Policy Graduate Program  
Department of Plant and Soil Sciences

From: Sandra Millard   
Interim Vice Provost and Director of Libraries

I am responding to your request to supply information about the capability of the University of Delaware Library to support permanent status for the Graduate Program in Water Science and Policy.

The University of Delaware Library with its strong interdisciplinary and electronic collections is well able to support this graduate program. Enclosed is a description of collections, resources and services available for this purpose.

I would be pleased to respond to any questions.

SM/nb  
Enclosure

c: Department of Plant and Soil Sciences  
Janine Sherrier, Professor and Interim Chair

University of Delaware Library  
Susan Davi, Associate Librarian, Head, Collection Management  
and Licensed Electronic Content Department  
M. Dina Giambi, Associate University Librarian for Technical Services and Resource Management  
Michael Gutiérrez, Librarian, Reference and Instructional Services Department  
Sarah Katz, Senior Assistant Librarian, Reference and Instructional Services Department  
Thomas Melvin, Librarian, Reference and Instructional Services Department  
Deb Morley, Head, Reference and Instructional Services Department  
Catherine Wojewodzki, Librarian, Scholarly Communication Officer



October 27, 2015

Report on Library Services and Collections in Support of  
Permanent Status for the Graduate Program in Water Science and Policy

General Description

The University of Delaware Library includes the Hugh M. Morris Library, where the main collection is housed; two branch libraries located on the Newark campus, the Chemistry Library and the Physics Library; and a third branch library, the Marine Studies Library, located in Lewes, Delaware. The Library collections parallel the University's academic interests and support all disciplines. The Graduate Program in Water Science and Policy is directly supported by the Library's strong collections in agriculture, applied economics and statistics, bioresources engineering, chemistry and biochemistry, climatology, engineering (civil, environmental, chemical and mechanical), environmental studies, geography, geology, marine science and policy, plant and soil sciences, and public policy.

Books, full-text electronic journals and electronic books, databases, periodicals, microforms, government publications, maps, manuscripts and media provide a major academic resource for the University of Delaware, the surrounding community, the state of Delaware and the nation. Library staff members provide a wide range of services.

The University of Delaware Library is a U.S. depository library and a U.S. patent depository library and contains the complete file of every patent issued by the U.S. Office of Patents and Trademarks.

The online catalog, DELCAT Discovery, provides access to millions of items by author, title, subject and keyword.

Library collections number over 2,800,000 and are broadly based and comprehensive. In 2014/2015, the Library Web <[library.udel.edu/](http://library.udel.edu/)> received over 2,200,000 virtual visits.

Specific Support for the Graduate Program in Water Science and Policy

The Library's collections are strong and are well able to support this graduate program. For many years, the Library has supported related graduate and undergraduate programs in plant and soil sciences, environmental studies, chemistry and biochemistry, climatology, all aspects of marine science and policy, engineering (including civil, environmental, chemical and mechanical), and public policy. The collections in these areas are excellent and continue to grow. Funds are designated at the beginning of each fiscal year for the support and strengthening of the collections

An experienced librarian, Sarah Katz, Senior Assistant Librarian, Reference and Instructional Services Department, serves as the Library liaison to the faculty in the College of Agriculture and Natural Resources. As Library liaison, Ms. Katz works with the College of Agriculture and Natural Resources to:

- Further develop Library collections, both print and electronic to support the teaching, learning and research needs of the College (CANR)
- Provide research support for faculty and students in a consultation setting
- Provide instruction in a classroom setting
- Serve as a resource for the information needs of the College (CANR) as they relate to the Library, Scholarly Communication, Open Access and other topics

Due to the highly interdisciplinary nature of this graduate program, several other librarians may also serve as contacts for this program. They are Tom Melvin (engineering, environment and energy, marine science and policy), Cathy Wojewodzki (chemical and biomolecular engineering, chemistry and biochemistry), Deb Morley (geography, geological sciences), and Michael Gutiérrez (public policy). These librarians are available to assist faculty as described above.

Library liaisons have developed and maintain 250 research guides <[guides.lib.udel.edu/](http://guides.lib.udel.edu/)> in all subject areas. These research guides direct students to a wide array of useful resources including databases, eJournals, eBooks, reference materials, visual material and more. In this context, Ms. Katz maintains a research guides for Water Science and Policy as well as guides for all other areas within the College of Agriculture and Natural Resources. Research guides in the areas of Public Policy and Administration, Engineering and Technology, Environmental and Earth Sciences, and Health Sciences are also available. Ms. Katz is also available to work with faculty to develop research guides for specific courses within this program.

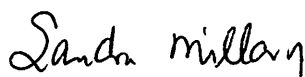
In addition to its extensive print-based collections, the Library provides access to more than 70,000 electronic journals <[library.udel.edu/ejournals/](http://library.udel.edu/ejournals/)> and 440,000 electronic books <[library.udel.edu/ebooks/](http://library.udel.edu/ebooks/)>. Within the Library's eJournal collection, the sciences are particularly strong, including almost all the journals published by Elsevier, Springer and Wiley as well as smaller publishers such as American Chemical Society, American Geophysical Union, American Meteorological Society, Environment and Energy Publishing, Annual Reviews, and GeoScienceWorld. Within the eBook collection, online access to all books published by Springer from 2010-present is of particular importance.

The Library subscribes to 370 online databases <[library.udel.edu/databases/](http://library.udel.edu/databases/)> which support research in all areas. Among the most important databases for the study and research of water science and policy are: *AGRICOLA*, *ASTM Standards and Digital Engineering Library*, *CAB Abstracts*, *Compendex*, *GeoRef*, *GREENR* (*Global Reference on the Environment, Energy and Natural Resources*), *GreenFILE*, *Environmental Sciences and Pollution Management*, *Knovel*, *Materials Research Database*, *Meteorological and Geostrophysical Abstracts*, and *Web of Science*.

The Library also subscribes to *RefWorks*, a web-based citation management tool that can be used with most databases.

The Library has strong collections of film and video <[library.udel.edu/filmandvideo/](http://library.udel.edu/filmandvideo/)> which support study and teaching in all subject areas.

The Library has a nationally recognized Student Multimedia Design Center <[library.udel.edu/multimedia/](http://library.udel.edu/multimedia/)> which provides access to equipment, software and training related to the creation of multimedia projects. The Student Multimedia Design Center includes over 80 workstations, six studios and two classrooms focused on multimedia creation. University of Delaware users also may borrow a wide variety of multimedia equipment. Through its Multimedia Literacy program, the Student Multimedia Design Center provides instructional support for faculty seeking to incorporate multimedia into their assignments.



Sandra Millard  
Interim Vice Provost and Director of Libraries

## **F. Self-study report**

1. General information about the program:

*a. Brief introduction and history of the program - include dates.*

Discussions for the Water graduate program were started in 2009 as a grass-roots effort by new and young faculty from four different colleges. Many of the newly hired faculties were doing significant interdisciplinary research and themselves had non-traditional and/or multi-disciplinary academic backgrounds. They wanted to recruit students from diverse disciplines to address their research questions and did not want students spending their valuable time taking all the necessary pre-requisites required for traditional departmental degrees. This is where the interdisciplinary program provided much flexibility and promise. The intent of the interdisciplinary Water program was:

- Encourage and enhance interdisciplinary research and education in the field of Water Sciences and Policy
- Expose and train students to the different perspectives that scientists from varying disciplines possess
- Foster science that can find solutions that are socially acceptable, environmentally sustainable and economically viable.
- Enhance faculty and student recruitment and retention
- Bring together faculty from diverse disciplines to address new emerging challenges in water sciences and policy
- Better train our students to think broadly across various scientific and policy aspects of their education
- Interact with industry, government, local community and other stakeholders on important water issues

In the fall of 2010, Delaware Environment Institute (DENIN) helped formalize this effort by coordinating the discussions and meetings of a faculty working group. The faculty working group developed an outline/framework for the graduate program and selected Shreeram Inamdar as the first Director for the program. Jeanette Miller and Amy Slocum from DENIN and Shreeram Inamdar developed the draft document for the graduate program and submitted it to the University Faculty Senate in spring 2011 for approval. The MS program in Water Science and Policy (<http://www.udel.edu/watersciencepolicy/>) was provisionally approved for five years with an effective date of September 1, 2011.

The program is administered by a director and a program committee composed of faculty from various colleges. Affiliated faculty include faculty from many departments across the four colleges who have interests in water research and education. These four colleges include – College of Agriculture and Natural Resources (CANR), College of Art & Sciences (CAS), College of Earth, Ocean, and the Environment (CEOE), and College of Engineering (COE).



Affiliated faculty can recruit and advise students. The list of affiliated faculty is routinely updated with inclusion of new faculty. The program is housed in the college of the Director, CANR in this case. Graduate students are associated with the college of the advisor and receive degrees in “Water Science & Policy” from the college of residence. Student funding or financial support is provided by the advisor or the department/college associated with the advisor. To receive the Water Science & Policy degree, students meet the requirements of the program alone and are not required to meet any other departmental requirements.

The first two MS students to the program (Matthew Bachman and Kate Miller) were admitted with full funding support in fall 2012. Both successfully graduated in the spring of 2014 and are now fully employed (details and support letters from the students are provided in the appendix). More students (3 to 4) are expected to graduate this fall/winter 2015. The program has been very successful in attracting and retaining the best students – additional details on application numbers, admitted and matriculated students are provided in the tables in the following sections. Currently the program has a total 18 graduate students including 12 MS and 6 PhD students. A full listing of all students is provided in a following table.

*b. Explain how the program is compatible with the academic priorities of the University.*

A strong educational program in Water Science & Policy will contribute to the scholarly and educational missions of the University—to *disseminate scientific, humanistic, and social knowledge for the benefit of the larger society and to produce graduates who are prepared to contribute to a global society, addressing the critical needs of the state, nation and global community.*

By enhancing graduate education and by facilitating new research partnerships among faculty and students in Water Science & Policy the program is a critical component of University’s strategic priorities in energy, environment, and life and health sciences.

*c. Explain how the program will help students meet the general education requirements of the University, specifically the ten (10) general education goals for undergraduate education (please note that this section applies only to undergraduate programs).*

Not applicable to this graduate program.

*d. Curricular requirements, including fulfillment of University, college and departmental requirements.*

Water Science & Policy students do not have to meet any additional college or departmental curriculum requirements. Students strictly follow the curriculum as laid out for the program (see attached program policy document in Section D).

Master’s students are required to complete 30 credit hours which include 24 course credits and six thesis credits. Courses are selected from the five areas as indicated in the curriculum chart



including - Physical sciences, Chemical and biological sciences, Research methods, Techniques, and Policy.

*e. Results of assessments or evaluations regarding the quality of the program - must indicate policies and procedures, how the assessment was used, and how the program changed because of it. What has the program accomplished in order to enhance assessment, particularly focusing on student learning outcomes?*

The key revisions or changes that have occurred because of internal evaluation and assessments are described below.

Research/Field Methods Course: All courses except one (“Research Methods”) in the program are existing courses. The Research Methods course was offered as a common, required, course to be taken by all program students. The intent was to train the students with a specific set of common tools or methods which the students could employ for their research and use to solve water and environmental challenges. The first offering of the 3-credit course included a two credit field methods course and a one credit seminar that focused on key water issues and challenges. However, following the first offering and after studying student course evaluations, the methods course was changed to a 3-credit Field Methods Course. Students indicated that the field methods section was a richer learning experience for them but the amount of work in that section exceeded the two-credit designation for that course section. Since then the 3-credit course has been offered twice (2014 and 2015) and has received strong support and good student evaluations.

Increase in policy faculty and courses: One of the challenges has been that the program has been heavier on the science versus the policy/social aspects – both in terms of the number of affiliated faculty as well as the courses in the program. This challenge stems from the lower number of policy faculty doing water-related research at the university. However, things have changed recently with the hiring of many new policy/economic faculty. We have actively sought out and accepted these new faculty into our program. Some of the new policy faculty include – Sunny Jardine (CEOE), Andrea Sarzynski (CAS), Leah Palm-Forster (CANR) and Afton Clarke-Sather (CEOE). New courses being taught by these faculties will be continuously added to the curriculum to increase the choice of policy courses available to students. In addition to policy faculty, we have also included other new science faculty in the program including Sara Rausher (CEOE) and Neil Sturchio (CEOE). The affiliated faculty listing is continuously revised and updated.

Establishment of Annual Water Symposium for Student Research Presentations: Since 2014, we have established and held an annual Water Symposium for our program students. The symposium is held in early fall (September) and the intent is – (a) to bring the cohort of program students together to present their research; (b) provide an opportunity for them to see the

research of their peers; (c) provide a venue for interaction and networking between students, faculty and working professionals from industry, government and non-profit organizations; (d) and have the opportunity to discuss the challenges and strengths of the program and any changes that may be needed. The annual symposium has been a big success and has met the desired goals! Symposium agendas (from 2014 and 2015) have been provided in the appendix.

Rotation in Program Committee Members initiated: In 2015, we also initiated a new strategy of rotation in program committee members. The intent was to bring in new ideas and perspectives, especially from new/younger faculty in the program. Drs. Don Sparks and Dan Leather agreed that this was a great idea and graciously stepped down to include new faculty in their place – Drs. Rodrigo Vargas and Amy Shober. We expect that such rotations will continue with rotation of members after 5 years of service on the program committee.

Advisor changes: Two MS students in the program switched advisors in the middle of their degree programs. The students contacted the Director and requested these changes. The Director discussed the problems with the students and the advisor and facilitated a smooth transition for the students. Both the students are doing very well with their new advisors and are on track to complete their MS degree.

*f. What are the department/unit's strategies for student advisement?*

Student advisement is provided primarily the advisor and the thesis committee. At least two members of the thesis committee need to be faculty affiliated with the Water Science and Policy program. The student develops his/her academic and research plan in close consultation with the advisor and the committee. It is the student's responsibility to meet program guidelines and deadlines and convey those in a timely manner to the Director/program office. If there are any concerns or problems with advisement the student is expected to meet and discuss those with the Director of the program. Student progress is monitored by the advisor and the committee and conveyed to the Director. Student progress is also evaluated during our annual Water Symposiums where all students are required to present a short talk on their research. These symposium talks also provide a great opportunity for program students to meet and connect with their peers and evaluate their own progress in comparison to their peers.

*g. If applicable, specify if the program meets all accreditation requirements (e.g., ABET, AACSB, APA, CADE etc.).*

Not applicable. The program does not have any accreditation requirements.

*h. Report any changes in the program admission criteria, degree requirements, or subject areas since the program was initiated.*

Advisor requirement at the time of admission: Selection of advisor by students was highly recommended (but not required) at the time of admission to the program. We have now made advisor selection a mandatory requirement. This was because of an experience with an international student from China who was admitted to the program but had a very difficult time finding an advisor after she joined the program. On paper, she was not a poor candidate (she met all the minimum admission criteria) but in person was not able to convince program faculty to serve as her advisor.

Funding highly recommended: While funding for admitted graduate students was always highly recommended, we are now emphasizing this to a greater extent. This is again based on our experience with an international student from China who initially indicated that she would fund herself and pay tuition. However, after arriving at UD the student expressed her inability to pay tuition because of family hardship. The student (a PhD candidate) has now transferred out of the Water Science and Policy program to the Department of Plant & Soil Sciences (where she found a faculty who was willing to serve as her advisor and provide a research assistantship).

New GRE scores: When this program was approved, ETS and the Graduate School were following the old GRE scoring scale (with the 800 maximum). ETS has now transitioned over to the new GRE scoring. To keep up with these changes, we are also now transitioning over to the new GRE scoring system. Our minimum criterion for admission is 50 percentile on the verbal and quantitative sections of the GRE.

- i. *General description of recruiting procedures - include any information for underrepresented populations.*

The program does not have any specific, common procedures or funds for student recruitment. All recruitments are conducted on a case-by-case basis and individually by affiliated faculty. Funding for student recruitment and travel is provided by the potential advisor – either through grant funding or from departmental funds.

Students have been recruited by faculty through a variety of ways – advertisements of assistantships and open graduate positions in professional society web sites and magazines, through emails to colleagues at universities in the region or across the nation, via blogs and email groups, online through their own web sites, and through advertisements at conferences and meetings.

The Water Science and Policy program Director and faculty have also participated in multiple student recruitment and outreach opportunities at UD including the Graduate Student fair, McNair Scholars program and similar meetings. We have set up booths where program faculty have met with prospective students, addressed their questions and handed out program fliers and

postcards. We have also advertised our program through meetings and conferences with faculty and students at Delaware State University and Del Tech.

Program fliers and postcards have also been mailed out to admission officers and undergraduate advisors at various universities in the mid-Atlantic region.

## 2. Student information:

- 1. Application and enrollment history - provide a tabular summary or graphical representation by year showing numbers of applicants, offers, matriculated, graduated, and dropped out (this data must be confirmed by the Admission's Office, the Registrar's Office, the Office of Graduate Studies or the Office of Institutional Research and Planning, as appropriate).*

Data for MS and PhD applicants from the Graduate School is provided below (information from Dr. Mary Martin):

Table 1: Data on MS and PhD students who applied to the program, were admitted, and those matriculated (Data from Graduate School).

<b>Plan Description</b>	<b>Plan Type2</b>	<b>App Year</b>	<b>Sum of Applied</b>	<b>Sum of Admitted</b>	<b>Sum of Matriculated</b>
Water Science and Policy	Doctoral	2011	1	1	1
		2012	6	2	2
		2013	9	6	2
		2014	14	5	3
		2015	3	0	0
	Master's	2012	6	2	2
		2013	15	12	4
		2014	16	8	6
		2015	14	4	2

Table 2: Listing of program students including home college, degree, admit term, and status (Data from Graduate School, Dr. Mary Martin). Names of the students have been removed to maintain confidentiality.

Acad Prog	Acad Plan	Admit Term	ChkoutStat	Degree	Notes
AGPHD	WSP-AG-PHD	Fall 2012			
AGMS	WSP-AG-MS	Fall 2012	Awarded	MS	
MSPHD	WSP-MS-PHD	Fall 2012			
AGPHD	WSP-AG-PHD	Fall 2012	Discontinued		Transferred to Plant & Soil Sciences
ASMS	WSP-AS-MS	Fall 2012	Awarded	MS	
AGPHD	WSP-AG-PHD	Fall 2013			
AGMS	WSP-AG-MS	Fall 2013			
MSMS	WSP-MS-MS	Fall 2013			
AGMS	WSP-MS-MS	Fall 2013			
MSMS	WSP-MS-MS	Fall 2013			
AGPHD	WSP-AG-PHD	Spring 2014			
ASPHD	WSP-AS-PHD	Fall 2014			
AGMS	WSP-MS-MS	Fall 2014			
ASMS	WSP-AS-MS	Fall 2014			
AGMS	WSP-MS-MS	Fall 2014			
AGPHD	WSP-AG-PHD	Fall 2013	Discontinued		Transferred to Plant & Soil Sciences
AGPHD	WSP-AG-PHD	Fall 2014			
AGMS	WSP-AG-MS	Fall 2014			
ASMS	WSP-MS-MS	Fall 2014			
MSMS	WSP-MS-MS	Fall 2014			
AGMS	WSP-MS-MS	Fall 2015			
AGMS	WSP-AG-MS	Fall 2015			

Number of students that have transferred out of the program = 2.

The two students who transferred out from the program were both international students from China. The first student wanted to get a more traditional degree and transferred to the Plant and Soil Sciences graduate program. The second student was initially admitted to the PhD program as a self-funded student. Initially, she had difficulty finding an advisor. She eventually found an advisor who agreed to advise and fund (RA) her if she transferred to the MS program in Plant and Soil Sciences.

2. *Annotated evidence of placement for students who have graduated - indicate how the department facilitates placement.*

The first two MS students from the program (Matthew Bachman and Kate Miller) graduated in 2014. Matt was awarded a degree from the College of Agriculture and Natural Resources whereas Kate got her degree from the College of Art and Sciences. Both are currently full employed. Letters from the two students are provided in the appendix. Employment details are listed below:

- Matthew Bachman – Water Resources Engineer and Planner, MWH Golbal, Sacramento, CA.
- Kate Miller - Watershed Institute Coordinator, Stony Brook-Millstone Watershed Association Pennington, New Jersey.

We expect another 3-4 MS students to graduate over the fall/winter of 2015. One of these students who plans to graduate in the fall has already accepted full-time employment with the Kent County Conservation District in Delaware.

The program (including the Director and affiliated faculty) receive many emails of potential job opportunities related to water and environmental science/policy. These opportunities are forwarded to the students. An example of one such potential job opportunity – forwarded by our own WSP student Matthew Bachman in his company is attached in the appendix.

As a part of the annual Water Symposium, the program also invites scientists, engineers, and policy makers from industry, governmental and non-governmental organizations. This provides an excellent opportunity for our students to network and interact with working professionals (see symposium agenda in appendix) and identify potential areas and organizations for employment. Many of the professionals participating in the symposium have indeed indicated that their organizations will be hiring and they will forward those advertisements to our students.

#### Other key student accomplishments:

Our students have excelled in academics and extra-curricular activities. Some of the key accomplishments include –

- Melissa Savin (MS) – Received the 2015 Benton Award for the best MS thesis in the College of Agriculture and Natural Resources. UDaily story - <http://www.udel.edu/udaily/2015/jun/benton-award-062215.html>
- Frances Bothfeld (MS) – Recipient of the 2016 Sea Grant Kanuss Fellowship. Web site - <http://seagrants.noaa.gov/FundingFellowships/KnaussFellowship/FinalistsCurrentFellows/2016Class.aspx>
- Alex Soroka (MS) – First Place award in the 2014 Pitch:90 competition. UDaily Story: <http://www.udel.edu/udaily/2015/nov/pitch90-112414.html>

3. *Identify sources and levels of financial support for students in the graduate program and indicate the proportion receiving assistantships\*.*

Most students in the program are primarily funded through research assistantships (RAs) from competitive grants obtained by program faculty. From 2012-2014, two assistantships were provided by the College of Agriculture and Natural Resources for a MS and PhD student each. Two academic year stipends (without tuition support, ~ \$16,500 each) have also been provided since 2013 by the Graduate School to CANR and which have been allocated to two WSP students.

WSP students in Geography have received some departmental support in terms of teaching assistantships.

3. Identify demand and competitive factors in the region, nationally or internationally for attracting students - explain how this benefits and/or challenges the program.

Climate change and extreme weather, unsustainable population growth and associated land-use change, and widespread pollution of our natural resources are threatening the quantity and quality of water resources worldwide. The extreme water scarcity in California because of drought, flooding in Louisiana, Texas and South Carolina because of hurricanes and tropical storms and contamination of drinking water supplies by toxic blue-green algae in Lake Erie (2014) are excellent examples of recent challenges. In the mid-Atlantic region including the Delmarva Peninsula and the Chesapeake Bay, new EPA water regulations (referred to as the “ditch rule”) and water pollution due to poultry manure the big drivers of environmental concern. These challenges are shaping funding, public policy, and regulatory decisions by local, state and federal governments and consequently the number and nature of jobs in the environmental sector.

Our interdisciplinary program is well poised to address these environmental challenges since we are training our students not only in sciences but also the economic and policy aspects related to these issues. As a matter of fact, considering the novelty and success of our interdisciplinary program, many other institutions in the region are following our lead. Virginia Tech has recently approved (2015) an undergraduate major in “Water: Resources, Policy, and Management “ (they consulted with us for the development of this major!).

Internationally, faced with pollution from manufacturing activities, water has become an important priority in China. The recent University of Delaware-Xiamen University Doctoral Student Memorandum highlights this issue very well. Since water was identified by the Chinese Government as an important priority, we received many applications (for fall 2015) from students from Xiamen University who wanted to pursue a doctoral degree in our program. These students come with their own stipend funding (tuition is waived by UD as per the memorandum of understanding). We have admitted one such qualified student who will join the program in spring 2016 (she was admitted for fall but postponed her arrival to spring). We expect many such applicants from other parts of the world – we have already received email queries from fully (self)-funded candidates from Saudi Arabia, Turkey, and other middle-east nations.

4. Identify factors that make this program unique or distinctive compared to similar programs at other institutions.

The key attributes that makes our Water Science & Policy program very attractive compared to similar program at other universities are:

- Combination of science as well as social/policy aspects. Majority of the water programs nationwide are focused predominantly on water science. Very few programs have a strong and integrated policy or social science component. The combination of science and policy and the associated faculty expertise is one of the key strengths of our program – this aspect is routinely highlighted by our incoming and prospective students.
- A university-wide graduate program. Having a program that is distributed across four different colleges is also a very unique attribute for our program. At many universities the water program is housed within one single college and/or department.
- A graduate degree titled “Water Science & Policy”. We are one of the very few programs nationwide that explicitly award a degree titled “Water Science & Policy”. In many universities the Water program is essentially a concentration under the broader degree program in Geology, Geography, Environmental Sciences, and Environmental Engineering.
- A program that has its own independent curriculum. To obtain a degree in Water Science & Policy our students have to only meet the stated requirements of our curriculum. They do not have to meet any other departmental or college curriculum requirements. This is another strong and unique feature of our program.

5. Overview of interdisciplinary relationships (if any) - include trends on what students choose for electives.

Given the interdisciplinary nature of this program, nearly all our graduate students are working with faculty across many disciplines. Many of our students have both science and policy faculty on their research committees. All of our students have to take courses spread across five disciplinary areas – physical sciences, chemical and biological sciences, policy, research methods, and statistics and analysis.

Students have a broad choice of courses in the science categories and typically select courses that are routinely offered or are relevant to their research. Water quality has been one of the key emphasis areas with respect to course selection. In comparison to physical/chemical/biological sciences, the choice of course offerings in the social and/or policy areas are lower because of the lower number of faculty affiliated with the program. We are trying to remedy this issue by actively soliciting and inviting new policy faculty to join our program. Environmental Economics and Regional Watershed Management are some of the courses that students typically



choose under the policy category – primarily because these courses are offered on a regular basis.

6. Characterize whether the facilities available for this program are adequate to support student, faculty, and staff needs.

Facilities and funding resources are an important challenge for new, university-wide, interdisciplinary program like ours. Currently, the university does not have a common, uniform, code or model to support interdisciplinary programs that are spread across multiple colleges. Graduate program support from departments and colleges is based on the traditional model where the program is housed within one department. This issue needs to be resolved for the long-term sustainability and future of interdisciplinary programs like ours and others ( BIOMES, Bioinformatics, etc.) at the university.

Currently, we do not have an annual recurring budget. Partial staff support is provided by our administrative home department – the Plant and Soil Sciences Department. There are no facilities (office space, etc.) specifically designated or allocated for this program. Faculty are housed in their home departments and their students are provided office space in that department. We hope this accommodation will continue.

Funding is needed for basic program items such as – seminars and symposiums, speaker fees and travel costs, student recruitment and campus visits, program advertisement, student travel to conferences, class field trips, and fellowships/assistantships. Since the Water Science and Policy program does not have its own listing of courses no funding is required for course teaching or S contracts.

In 2014, at the request of the Director, the Dean of the College and Agriculture and Natural Resources (administrative home college of this program) generously provided a lump-sum amount of \$7000. We have used this allocation to fund our two water symposiums (in 2014 and 2015) and for student recruitment and campus visits. However, for the future of the program, a more sustainable, recurring, model of funding needs to be developed and adopted.

7. Provide information on other budgetary requirements of the program beyond the typical unit expenses.

Other than the items listed above, we do not have any other budgetary requirements.

8. Other information of value for the review of the program.

None.

**G. Appendices for supporting documentation, as appropriate.**

1. Support letters from the Deans –
  - a. College of Agriculture and Natural Resources (CANR)
  - b. College of Arts and Sciences (CAS)
  - c. College of Earth, Ocean, and the Environment (CEOE)
  - d. College of Engineering (COE)
2. Support letter from the Chair of the Department of Plant and Soil Sciences (administrative home of the program)
3. Letters from MS students who have graduated from the program –
  - a. Kate Miller
  - b. Matthew Bachman
4. Listing of Current WSP Faculty
5. Water Symposium programs –
  - a. For 2014
  - b. For 2015
  - c. UDaily article on 2015 Symposium
6. Example job opportunity/advertisement for our MS graduates



College of Agriculture  
& Natural Resources  
OFFICE OF THE DEAN

113 Townsend Hall  
531 South College Avenue  
Newark, DE 19716-2103  
Phone: 302-831-2501  
Fax: 302-831-6758

October 20, 2015

Professor Shreeram Inamdar  
Director, Water Science & Policy Program  
Department of Plant & Soil Sciences  
152 Townsend Hall  
University of Delaware  
Newark, DE 19711

Dear Shree,

The College of Agriculture and Natural Resources enthusiastically supports the permanent approval of the Master of Science in Water Science & Policy (WSP) program.

The program has done well over the provisional period with two MS students graduated in 2014 (both employed) and 12 MS students currently enrolled in the program. The current strength of 18 graduate students (MS and PhD) in the program clearly attests to the interest and enthusiasm for the program. Your leadership has been instrumental to the initial success of the program, and I am sure it will continue to grow under your watch.

With faculty and students spread across all four colleges, the interdisciplinary graduate program has helped forge valuable new partnerships across colleges and departments in water science and policy. The program has especially been beneficial for new faculty for recruiting talented and exceptional graduate students. We wish you continued success with the program.

Sincerely,

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

Mark Rieger, Dean and Professor

October 14, 2015

Professor Shreeram Inamdar  
Director, Water Science & Policy Program  
Department of Plant & Soil Sciences  
152 Townsend Hall University of  
Delaware Newark, DE 19711

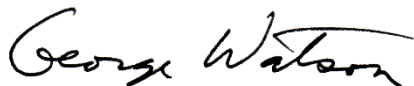
Dear Dr. Inamdar:

The College of Arts and Sciences supports your efforts for the permanent approval of the Master of Science degree program for the Water Science & Policy (WSP) graduate program.

I understand the program has done well over the provisional period with two MS students graduated in 2014 (both employed) and 12 MS students currently enrolled in the program. Three of the WSP graduate students have been advised and supported by Gerald Kauffman, Director of the University of Delaware Water Resources Center in the School of Public Policy and Administration in the College of Arts and Sciences. The current strength of 18 graduate students (MS and PhD) in the program attests to the interest and enthusiasm for the program.

With faculty and students spread across four colleges, the interdisciplinary graduate program has helped forge valuable new partnerships across colleges and departments in water science and policy. The program has especially been beneficial for new faculty for recruiting talented and exceptional graduate students. We wish you continued success with the program.

Sincerely,

A handwritten signature in black ink that reads 'George Watson'.

George H. Watson, Dean College of  
Arts and Sciences

cc: Gerald Kauffman, School of Public Policy and Administration



College of Earth, Ocean,  
& Environment  
OFFICE OF THE DEAN

111 Robinson Hall  
Newark, DE 19716-3501 U.S.A.  
Phone: 302-831-2841  
Fax: 302-831-4389  
Email: [ntargett@udel.edu](mailto:ntargett@udel.edu)

October 27, 2015

Professor Shreeram Inamdar  
Director, Water Science & Policy Program  
Department of Plant & Soil Sciences  
152 Townsend Hall  
University of Delaware  
Newark, DE 19711

Dear Shree,

The College of Earth, Ocean, and Environment fully supports your efforts for the permanent approval of the Master of Science degree program for the Water Science & Policy (WSP) graduate program.

The program has done well over the provisional period with two MS students graduated in 2014 (both employed) and 12 MS students currently enrolled in the program. The current strength of 18 graduate students (MS and PhD) in the program clearly attests to the interest and enthusiasm for the program.

With faculty and students spread across all four colleges, the interdisciplinary graduate program has helped forge valuable new partnerships across colleges and departments in water science and policy. The program has especially been beneficial for new faculty for recruiting talented and exceptional graduate students. We wish you continued success with the program.

Sincerely,

A handwritten signature in black ink that reads 'Mohsen Badiey'.

Mohsen Badiey  
Acting Dean, College of Earth, Ocean, and Environment

October 20, 2015

Professor Shreeram Inamdar  
Director, Water Science & Policy Program  
Department of Plant & Soil Sciences  
152 Townsend Hall  
University of Delaware  
Newark, DE 19711

Dear Shree,

I am writing to express the College of Engineering's enthusiastic support for the permanent approval of the Master of Science degree program in Water Science & Policy (WSP).

The program has done well over the provisional period, having graduated two MS students in 2014 (both employed), and with 12 MS students currently enrolled. The current strength of 18 graduate students (MS and PhD) in the program attests to the interest and enthusiasm for the program, and indicates clear evidence of its sustainability.

This interdisciplinary graduate program, whose faculty and students span four colleges, has forged valuable new partnerships in water science and policy across many departments at UD. The program has been especially beneficial for new faculty in facilitating the recruitment of talented and exceptional graduate students.

I look forward to the program's continued success.

Sincerely,



Babatunde A. Ogunnaike, Ph.D.  
Dean and  
William L. Friend Chaired Professor of Chemical Engineering



October 19, 2015

Professor Shreeram Inamdar  
Director, Water Science & Policy Program  
Department of Plant & Soil Sciences  
152 Townsend Hall  
University of Delaware  
Newark, DE 19711

Dear Shree,

The Department of Plant and Soil Sciences (PLSC) in the College of Agriculture and Natural Resources fully supports your efforts for the permanent approval of the Master of Science degree program for the Water Science & Policy (WSP) graduate program.

The program has done well over the provisional period with two MS students graduated in 2014 (both employed) and 12 MS students currently enrolled in the program. The current strength of 18 graduate students (MS and PhD) in the program clearly attests to the interest and enthusiasm for the program.

With faculty and students spread across four colleges, the interdisciplinary graduate program has helped forge valuable new partnerships across colleges and departments in water science and policy. The program has especially been beneficial for new faculty for recruiting talented and exceptional graduate students.

We wish you continued success with the program.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Janine Sherrier'.

D Janine Sherrier, PhD  
Interim Chair, Department of Plant and Soil Sciences

Kate Miller Hutelmyer  
301 Heights Ln., Apt. 1D  
Feasterville, PA 19053  
10/26/2015

Shreeram Inamdar, PhD  
Professor of Watershed Hydrology and Biogeochemistry  
Director, Water Science & Policy Graduate Program  
Plant & Soil Sciences Department  
152 Townsend Hall  
531 S College Avenue  
University of Delaware  
Newark, DE. 19716

Dear Dr. Inamdar,

It is my pleasure to write this letter in support of the Water Science and Policy Graduate Program. The field of water resource management is growing ever more important, and this program is a fantastic launching point for those who are passionate about our most vital natural resource.

The program's combination of coursework, practical application, and intensive networking have been invaluable for me. Having an interdisciplinary degree with a holistic focus on water management set me apart from other candidates in the job search, and I use that holistic approach every day in my work as a program coordinator for a watershed association. In addition, I am deeply grateful for the sense of community that surrounds the Water Science and Policy Program, both among students and faculty. It made my graduate school experience that much more rewarding.

Thank you for the opportunity to submit this letter, and I wish you continued success with this wonderful program!

Best regards,

Kate Miller Hutelmyer  
M.S. Water Science and Policy (2014)



The Water Science and Policy (WSP) program at University of Delaware was exactly what I was looking for in a Master's program. Coming from a primarily engineering background, I very much appreciated the thoughtful blending of quantitative and qualitative classes that provided me with a much more holistic view of the water resources discipline and the issues we face. Working closely alongside professors both in the classroom and in the field has absolutely left me with lessons that I can apply at my job, where I work with professionals ranging from engineers to economists to biologists and more.

Outside of classwork, I also enjoyed the thesis work that the WSP program allowed me to undertake. Working alongside Dr. Inamdar was a rewarding experience, as I was able to not only collaboratively share ideas about what the data was "saying" as I worked, but I was able to get answers to questions in real-time that moved me forward in the right direction. The end product was the result of input from a variety of fields and backgrounds, and I think it came out better for it.

I am very grateful to have come through the Water Science and Policy program, and would recommend it to anyone looking to broaden and sculpt their knowledge of water resources!

A handwritten signature in black ink, appearing to read 'Matthew Bachman', with a long horizontal flourish extending to the right.

Matthew Bachman  
M.S. Water Science and Policy, 2014

2616 P Street  
Unit 1  
Sacramento, CA 95816

### Water Science & Policy Faculty (October, 2015)

<b>Faculty name</b>	<b>College</b>	<b>Department</b>
Shreeram Inamdar, Director	CANR	Plant & Soil Sciences
<b>Program Committee</b>		
Luc Claessens	CEOE	Geography
Joshua Duke	CANR	Applied Economics & Statistics
Paul Imhoff	COE	Civil & Environmental Engineering
Gerald Kauffman	CAS	School of Public Policy & Administration
Delphis Levia	CEOE	Geography
Holly Michael	CEOE	Geology
Amy Shober	CANR	Plant & Soil Sciences
Rodrigo Vargas	CANR	Plant & Soil Sciences
<b>Affiliated Faculty</b>		
Carmine Balascio	CANR	Plant & Soil Sciences
Jacob Bowman	CANR	Entomology & Wildlife Ecology
Daniel Cha	COE	Civil & Environmental Engineering
Tracy DeLiberty	CEOE	Geography
Dominic DiToro	COE	Civil & Environmental Engineering
Cathleen Geiger	CEOE	Geography
Judy Hough-Goldstein	CANR	Entomology & Wildlife Ecology
Chin-Pao Huang	COE	Civil & Environmental Engineering
Sunny Jardine	CEOE	School of Marine Science & Policy
Deb Jaisi	CANR	Plant & Soil Sciences
Yan Jin	CANR	Plant & Soil Sciences
Daniel Leathers	CEOE	Geography
David Legates	CEOE	Geography
Julia Maresca	COE	Civil & Environmental Engineering
Kent Messer	CANR	Applied Economics & Statistics
Leah Palm-Forster	CANR	Applied Economics & Statistics
James Pizzuto	CEOE	Geology
Sara Rausher	CEOE	Geography
Afton Clarke Sather	CEOE	Geography
Andrea Sarzynski	CAS	School of Public Policy & Administration
Donald Sparks	CANR	Plant & Soil Sciences
Yda Schreuder	CEOE	Geography
Neil Sturchio	CEOE	Geology
Angelia Seyfferth	CANR	Plant & Soil Sciences
Young-Doo Wang	CAS	Center for Energy & Environmental Policy
Christopher Williams	CANR	Entomology & Wildlife Ecology
Eric Wommack	CANR	Plant & Soil Sciences



# **Water Science & Policy Graduate Program**

## *First Annual Symposium*

September 26, 2014

2-6:30 pm

Townsend Hall

Commons



# SYMPOSIUM AGENDA

**September 26, 2014; Townsend Hall Commons; 2 – 6:30 pm**

- 2 pm            Welcome by Shreeram Inamdar, Director Water Science and Policy Program
- 2:10 pm        Opening remarks by Dr. Mark Rieger, Dean, College of Agriculture and Natural Resources
- 2:20 pm        Seminar introduction and protocol by Alex Soroka and Jennifer Egan (WSP students) and seminar setup
- 2.30pm        **Short talks by Senior WSP students** (see student list and talk titles below). Each talk will be 10 min long including 2-3 minutes for questions and feedback from audience
- 3.30pm        **Lightning talks by Junior WSP students** - 5 min each with 1-2 minutes for feedback
- 4.30 pm        **Panel discussion by Water Professionals and Scientists**
- 5.30pm        First place awards for best student talks (senior & junior student category)
- 5.40 pm        Informal networking and hors d'oeuvres in Townsend Commons
- 6:30 pm        Adjourn



# Panelists for Water Science & Policy Symposium



**Mr. A. Scott Andres**, Senior Scientist, Delaware Geological Survey. Scott Andres has been a hydrogeologist with the Delaware Geological Survey since 1984 and is an Associate Professor with the Dept. of Geological Sciences. His recent research includes effects of land based disposal of wastewater on soils and waters, nutrient cycling and watershed analyses for Delaware's total maximum daily load program, ground-water modeling, submarine groundwater discharge, and large scale mapping and characterization of aquifer geometries and hydraulics.



**Ms. Judy Denver**, Project Chief, NAWQA, USGS. Since 1997, Judy has been the Project Chief for the National Water-Quality Assessment Program (NAWQA), Delmarva Peninsula and Potomac River Basin and Delmarva Peninsula Study Units. Her research interests include study of the geochemistry of shallow Coastal Plain groundwater systems affected by agricultural, urban, and forested land uses. She has a BS in Geology and MS in Marine Studies, both, from the University of Delaware.



**Mr. Andrew T. Der**, Principal, Andrew T. Der & Associates, LLC. Mr. Der is a regionally recognized water resource industry leader with 30 years of professional experience in the Mid-Atlantic region committed to providing equitable, sustainable, and compliant solutions to complex projects. Mr. Der's project-critical deliverables include assessments, feasibility studies, and regulatory compliance. He has served 17 years with the Maryland Department of the Environment and 13 years as a private-sector environmental consultant providing regulatory, technical and scientific expertise for public and private clients.



**Dr. Richard Greene**, Environmental Engineer, Delaware Department of Natural Resources and Environmental Control (DNREC). Dr. Greene is responsible for the assessment of toxic contaminants in Delaware surface waters, sediments and fish tissue. He has managed Delaware's fish consumption public health advisory program since its inception in 1993 and has been involved in all advisories issued by Delaware. Dr. Greene holds a Ph.D. in environmental engineering from the University of Delaware.



**Mr. Charles Hegberg**, Skelly & Loy Inc., and President, reGENESIS, Global Solutions LLC. Chuck, has nearly 30 years of technical and management experience in natural and water resources planning and ecological restoration markets globally. He is currently working on or has completed projects in The Gambia and Ghana, West Africa, Haiti and China. Over the years, he has developed a strong reputation for being a visionary, entrepreneurial leader working to bring innovative, market-based solutions to some of the most complex environmental and community redevelopment projects.



# Panelists for Water Science & Policy Symposium



**Dr. Lyndie Hice-Dunton**, Research Coordinator, Delaware National Estuarine Research Reserve (DNERR)  
Lyndie received a B.S in Marine Science from Eckerd College on Florida's Gulf coast, and a Ph.D. in Marine and Atmospheric Sciences from Stony Brook University in New York in 2010. Much of her research with the DNERR focuses on long term research and monitoring programs to investigate the potential impacts of climate change and sea level rise on coastal ecosystems. Most recently the DNERR research staff has been working to have the Reserve officially designated as a NERRS Sentinel Site for climate change impacts.



**Ms. Jeanette Miller**, Associate Director, DENIN  
Jeanette Miller oversees the Institute's grants and development strategy, education programs and communications. Miller worked closely with the Water Science & Policy faculty during the program's development phase. Prior to her work with DENIN, Miller was Assistant Director of the Delaware Biotechnology Institute for 10 years. Her early career was focused on international development; Miller managed international programs funded through USAID, primarily in Eastern Europe and W. Africa.

## Example questions for Water Panel Discussion

**Panel will discuss external and internal issues relevant to the Water Science and Policy program.** These could include (among others) -

- *What are the key water and watershed priorities in the Mid-Atlantic and how can our students address those priorities?*
- *How can our students better prepare for the water/environmental job market? What types of skills are employers looking for? What tips and suggestions can the panel provide to our students?*
- *What types of new research and educational partnerships can our students and faculty develop with industry, state, federal scientists and engineers and non-profit organizations? How can the Water Science and Policy program facilitate this interaction?*
- *Is there interest with the industry and government scientists for a professional Master's degree program (non-thesis) in Water Science & Policy?*
- *How can we enhance within-program collaborations and interactions between WSP students and faculty?*

*Panel Facilitators – Frances Bothfeld (WSP student) & Shreeram Inamdar*

**WSP Student talks:** student name, degree being sought, advisor in brackets, and title

**Senior students (10 minute talks including 2-3 min questions):**

- **Tom Santangelo**, MS, (Luc Claessens). *Geospatial analysis of Nitrogen Removal by Riparian Buffers*
- **Frances Bothfeld**, MS, (Angelia Seyfferth). *Unravelling the Effects of Biogeochemical Processes on Green House Gas Flux in an Estuarine Environment*
- **Jennifer Egan**, PhD, (Joshua Duke). *Policy Analysis: Agricultural nonpoint source nutrient pollution*
- **Melissa Savin**, MS, (Amy Shober). *Characterizing Phosphorus in Agricultural Ditch Sediments to Guide Effective Ditch Management*
- **Fang Tan**, PhD, (Holly Michael and Paul Imhoff). *The Co-evolution of Soil Hydraulic Properties and Mineral Weathering and the Impact of Farming on Mineral Weathering*
- **Alex Soroka**, MS, (Amy Shober). *Effects of in-Season Fertilization Strategies on Nitrogen Use Efficiency and Yield of Irrigated Corn*

**Junior students (5 minute talks including 1-2 min questions):**

- **Matthew Miller**, part-time PhD, (Shreeram Inamdar), *Drinking Water Quality and Extreme Weather Events: A Juggling Act for Utilities*
- **Dan Warner**, PhD, (Shreeram Inamdar & Rodrigo Vargas). *Topographically regulated relationships between soil organic matter and greenhouse gas fluxes*
- **Sandra Petrakis**, MS, (Rodrigo Vargas). *Examining the underlying processes controlling Greenhouse Gas Flux responses in soils through high temporal frequency measurements*
- **Richard Rowland**, MS, (Shreeram Inamdar). *Particulate Organic Matter Responses to Extreme Weather Events Across Watershed Land Use and Scale: a Combined Approach using In-Situ Monitoring and Multiple Tracers*
- **Catherine Winters**, MS, (Shreeram Inamdar). *Dissolved carbon and nitrogen responses to extreme weather events and seasonal hot moments: An assessment using high-frequency sensors*
- **Kelsey Moxey**, MS, (Luc Claessens). *Evaluating nitrogen mitigation potential in a spatially diverse watershed*
- **Kristen Molfetta**, MS, (Gerald Kauffman). *Drinking water resources, watershed management, water policy, water law, New York City water supply*
- **Samuel Villarreal**, PhD, (Rodrigo Vargas). *Climate variability on evapotranspiration dynamic across different ecosystem types*
- **Matt Ludington**, MS, (Gerald Kauffman). *Water Resources and their Connection to Modern Natural Gas Extraction*
- **Joe Brown**, PhD, (Gerald Kauffman). TBD.



# **2015 Water Symposium**

## *Water Science & Policy Graduate Program*

September 25, 2015

3- 7 pm

Townsend Hall  
Commons





# SYMPOSIUM AGENDA

September 25, 2015; Townsend Hall Commons; 3 – 7 pm

3 pm Welcome by Shreeram Inamdar, Director, Water Science and Policy Program

3:05 pm Opening remarks by Dr. Mark Rieger, Dean, College of Agriculture and Natural Resources

3:15 pm **Plenary talk by Dr. Don Boesch**

***Science and Policy in the Chesapeake Bay:  
The Long-Haul and the Tight Crunch***

4:10 pm Short Break

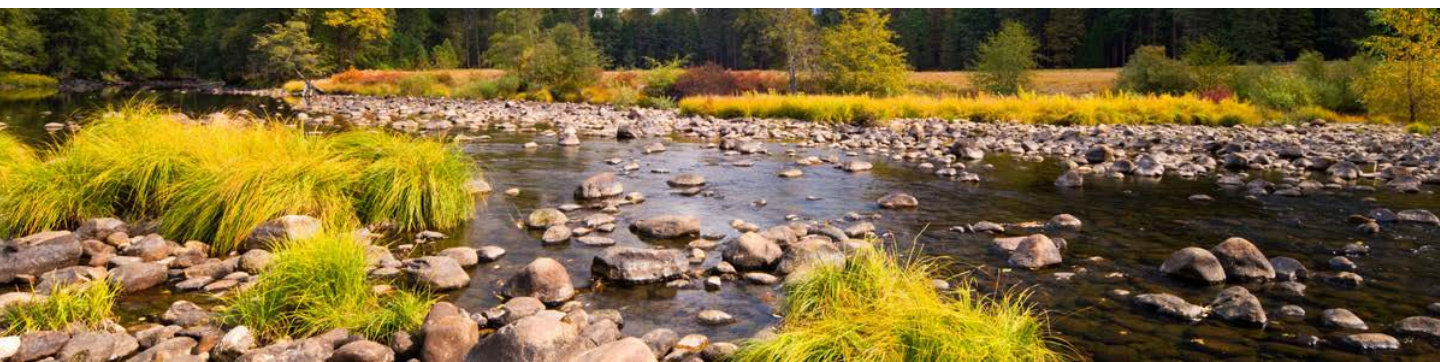
4:15 pm **WSP student presentations** (15 talks at 5 minutes each for 75 min) Moderated by Alex Soroka & Matthew Miller

5:30 pm Break for hors d'oeuvres

6 pm **Panel Discussion**

6:35 pm Informal networking and hors d'oeuvres in Townsend Commons

7 pm Adjourn



# Plenary Speaker



**President Dr. Donald Boesch**

Dr. Donald Boesch is a Professor of Marine Science and President of the University of Maryland Center for Environmental Science, a part of the twelve-institution University System of Maryland.

From June 2002 through October 2003, Dr. Boesch also served as Interim Vice Chancellor for Academic Affairs of the University System of Maryland. In 2008, Dr. Boesch was given the additional responsibility of Vice Chancellor for Environmental Sustainability to lead the University System's Environmental Sustainability Initiative.

A native of New Orleans, Dr. Boesch received his B.S. from Tulane University and Ph.D. from the College of William & Mary. He was a Fulbright Postdoctoral Fellow at the University of Queensland and subsequently served on the faculty of the Virginia Institute of Marine Science. In 1980 he became the first Executive Director of the Louisiana Universities Marine Consortium, where he was also a Professor of Marine Science at Louisiana State University. He assumed his present position in Maryland in 1990.

Dr. Boesch is a biological oceanographer who has conducted research in coastal and continental shelf environments along the Atlantic Coast and in the Gulf of Mexico, eastern Australia and the East China Sea. He has published two books and more than 90 papers on marine benthos, estuaries, wetlands, continental shelves, oil pollution, nutrient over-enrichment, environmental assessment and monitoring and science policy. Presently, his research focuses on the use of science in ecosystem management.

# Panelists for Water Science & Policy Symposium



**Jennifer Adkins**, Executive Director, Partnership for the Delaware Estuary  
Jennifer Adkins was appointed to the position of executive director of the Partnership for the Delaware Estuary in October of 2007. She also served as the nonprofit's Schuylkill Watershed Initiative Grant coordinator for over two years, during which she managed a \$1.15 million grant from the U.S. Environmental Protection Agency to fund a series of projects undertaken by the Schuylkill Action Network in southeastern Pennsylvania. Adkins has a master of public administration degree from University of Delaware and a bachelor of science degree in economics.



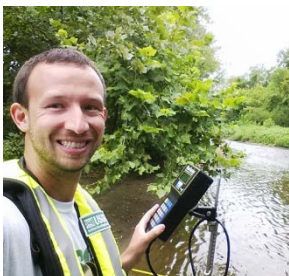
**Christina Casole**, Water Resources Engineer, Skelly & Loy, Inc.  
Christina Casole graduated from The Pennsylvania State University with a BS in Civil Engineering in 2002 and is currently in graduate school at The Johns Hopkins University pursuing her MS in Environmental Science and Engineering. Ms. Casole is water resources engineer with more than 12 years of experience, specializing in stream restoration, watershed assessment, stormwater management, floodplain analysis, and erosion and sediment control design and currently works for Skelly and Loy, Inc.



**Ed Hallock**, Program Administrator, Office of Drinking Water  
Ed received a Bachelors Degree in Biology from the University of Delaware in 1981. He began his public health career in 1983. He became the Program Manager for Office of Drinking Water in 1991 and Program Administrator in 1999. He was the past President of the Association of State Drinking Water Administrators (ASDWA). He is a Member of AWWA and past Trustee of the CSAWWA.



**Alison Kiliszek**, Engineer, Delaware Department of Natural Resources and Environmental Control (DNREC) .  
Alison Kiliszek received a B.S. in Environmental Engineering and M.S. in Bioresources Engineering from the University of Delaware. She is currently an Engineer with DNREC's Solid and Hazardous Waste Management Section and monitors the regulatory compliance of Municipal Solid Waste and Industrial Waste Landfills within Delaware.



**Christopher Nealen**, Hydrologist, US Geological Survey  
Chris has been with the U.S. Geological Survey for about a year and a half and currently serve as a surface water hydrologist in the water resources division. His work is mainly concerned with stream gaging and sediment transport through watersheds. He holds a BS in Biology/Environmental Sciences and a MS in Environmental Science and Policy focused on water resources.

# Panelists for Water Science & Policy Symposium



**Mark Strickland**, Water Resource Engineer, Century Engineering, Inc. Mark Strickland is a recent graduate of the University of Delaware (Class of 2013) with a Civil Engineering major and an Environmental Engineering minor. Upon graduation he accepted a position with Century Engineering, Inc. (CEI) as a Water Resource Engineer, and began working towards his Master's in Civil Engineering at UD as a part-time student in the fall of 2013. His experience at CEI primarily concerns stormwater/drainage design, site planning/development, erosion and sediment control design, watershed scale water quality improvement plans, and wetland monitoring/management.



**Larry Trout**, Senior Manager, Water Resources, RK&K Mr. Larry Trout, Jr., P.E. is currently a Senior Manager with RK&K. With over 21 years of experience, he has a unique expertise in water resources engineering. Areas of specialty include stormwater management, green stormwater infrastructure, stream restoration, hydraulic and hydrologic routing, watershed modeling, drainage studies, floodplain modeling, erosion and sediment control, coastal erosion control, flood control design, and master drainage plan preparation throughout the Northeast. Mr. Trout is a graduate of Bucknell University with both a Master and Bachelor of Science in Civil Engineering.

## Example questions for Water Panel Discussion

**Panel will discuss external and internal issues relevant to the Water Science and Policy program.** These could include (among others) -

- *How can our students better prepare for the water/environmental job market? What types of skills are employers looking for? What tips and suggestions can the panel provide to our students?*
- *What types of new research and educational partnerships can our students and faculty develop with industry, state, federal scientists and engineers and non-profit organizations? How can the Water Science and Policy program facilitate this interaction?*
- *What are the key water and watershed priorities in the Mid-Atlantic and how can our students address those priorities?*
- *How can we enhance within-program collaborations and interactions between WSP students and faculty?*

**Panel Facilitators – ?????**

## WSP Student Talks and Titles

Name	Advisor	Title
Alexander Soroka (MS)	Amy Shober	Effect of In-Season Fertilization Strategy on the Yield and Nutrient Use Efficiency of Irrigated Corn
Catherine Winters (MS)	Shree Inamdar	Pulse of the stream: Rapid carbon and nitrogen changes in stream water using in-situ, high-frequency, water quality sensors
Daniel Warner (PhD)	Shree Inamdar	From Ridge Top to Valley Bottom: Soil Greenhouse Gas Fluxes Across Complex Terrain
Fang Tan (PhD)	Holly Michael & Paul Imhoff	The Impact of Soil Organic Matter and Farming on Mineral Weathering
Joseph Brown (PhD)	Jerry Kauffman & Paul Imhoff	A Field Study of Biochar Amended Soils
Kelsey Moxey (MS)	Luc Claessens	Identifying non-point sources of nitrogen loading from mushroom production - a remote sensing approach
Kristen Molfetta (MS)	Jerry Kauffman	Watershed Management in the First State National Park: An inter-agency collaboration of water quality sampling & stream network monitoring
Matthew Ludington (MS)	Jerry Kauffman	Investigating Sources of Investment in the Delaware River Basin
Mathew Miller (PhD)	Shree Inamdar & Kent Messer	Extreme Weather and Drinking Water Utilities: Impacts, Risks, and Tough Decisions
Richard Rowland (MS)	Shree Inamdar	Rolling down the River: Source and Transport of Particulate Organic Matter in a Headwater Stream Network
Samuel Villarreal (PhD)	Rodrigo Vargas	Ecosystem functioning across North America: Its representativeness, variability and forecasting
Sandra Petrakis (MS)	Rodrigo Vargas	The Influence of Extreme Water Pulses on Greenhouse Gas Emissions from Soils
Thomas Santangelo (MS)	Luc Claessens	Where should riparian buffer restoration be prioritized to maximize nitrogen removal?
Erin Johnson (MS)	Shree Inamdar	Stream microbial networks: Coupled investigation of sediment composition and microbial communities and their fate and transport through a stream network.
Chelsea Krieg (MS)	Shree Inamdar	After the storm: Nitrogen cycling in flood sediments and impacts on water quality

Not presenting: Jennifer Egan (PhD), Melissa Savin (MS), and Frances Bothfeld (MS)





# UDaily



Donald Boesch discusses science and policy as it relates to the Chesapeake Bay.

## Water symposium

### Second annual UD water symposium focuses on science, policy

1:15 p.m., Oct. 2, 2015--University of Delaware students and faculty, as well as professionals from industry, government and non-profit organizations, gathered in the Townsend Hall Commons on Friday, Sept. 25, as part of the second annual Water Science and Policy Symposium.

Donald Boesch, professor of marine science and president of the University of Maryland Center for Environmental Science, served as the plenary speaker for the event and addressed his experiences with a talk titled "Science and Policy in the Chesapeake Bay: The Long-Haul and the Tight Crunch."

Boesch discussed the physical characteristics of the bay and how those characteristics that define its vulnerability — such as shallow waters, unique shoreline dimensions and a drainage catchment that includes six states — are also what make it such a productive ecosystem.

Boesch said that when studying the Chesapeake, it is important to understand the bay beyond its geological history. "Humans have always had some impact on the Chesapeake Bay, even the small populations of Native Americans in terms of local resources, but it really started to grow substantially with the advent of the migration of the large number of Europeans into North America," he said.

This impact was mainly through deforestation.

"When they used the landscape to grow tobacco and other crops, they were making it change from being a clear water, nutrient limited system that is still highly productive to one that is now turbid and eutrophic, which has more nutrients, one that is highly productive but doesn't necessarily lead to the same kinds of outcomes in terms of higher trophic levels," said Boesch.

Boesch pointed out some of the scientific pioneers who have studied the Chesapeake Bay, including L. Eugene Cronin, who conducted research on the blue crab beginning in the 1950s; Bill Hargis, who was the director of the Virginia Institute of Marine Science from its founding in 1959 until 1981; and Don Pritchard, who studied the bay for 50 years and discovered that it contains two layers of water — lighter fresh water on top and salty water along the bottom.

He also pointed out statistics, such as how the oyster population of the bay is less than one percent of historic levels due to loss of habitat and filtration capacity.

Boesch said that industrial agriculture as part of the Green Revolution had an impact on the Chesapeake, as did Hurricane Agnes in 1972, which he said was like a "big flush" that brought drought-like conditions to the area.

He also said that in recent years, models have been used to estimate how much phosphorous and nitrogen is entering the bay but that the

models must confront reality and that it is essential to bring together models and observations to make an adaptive management cycle to help the body of water.

Boesch stressed that when working on science with regard to the Chesapeake Bay, it is important to remember that people's economic livelihoods are tied to it, which may make them hesitate to adopt environmental friendly practices such as restricting the number of oysters they are able to harvest. It also is important to be able to communicate complicated research to policy makers who may not be familiar with the research.

Boesch ended his talk by giving examples of how science and policies — specifically those aimed at reducing nitrogen and phosphorous inputs — has helped to improve portions of the Chesapeake.

“There are some pretty good success stories about science in the bay that were made through a sustainable use of resources. Striped bass were really in a bad situation and now a lot of those populations have recovered,” he said. “They are doing the same thing in managing blue crab in parts — if you see that it's a female, you don't want to catch one because they have a lot of eggs ready to go — and we have massive oyster restoration, trying to rebuild sea populations rather than just put oysters back in.”

Boesch ended by talking about how climate change and sea-level rise will play a role in all environmental science fields now and into the future, and pointed to the Maryland and Delaware Climate Change Education Assessment and Research (MADE-CLEAR) as an example of a program working to engage climate scientists, science educators and the broader community of interest in implementing a comprehensive climate change education plan in the region.

The conference was opened by Shreeram Inamdar, professor in the Department of Plant and Soil Sciences in UD's College of Agriculture and Natural Resources (CANR) and director of the water science and policy graduate program who organized the symposium, who welcomed the participants and talked about the interdisciplinary nature of the event.

“Since the water graduate program is spread across the University, there are students here from many colleges and departments. I think the symposium is important because it provides the opportunity for these students to connect with each other, see what others are working on, and also connect with water science faculty,” said Inamdar. “Most importantly, however, I want these students to connect with working professionals, and we have some great guests on hand to speak with the students about their professions.”

CANR Dean Mark Rieger spoke about how the symposium is growing and how it was significant to see students sitting along professionals from industry and government.

“It is important to have science-based research to determine what we do with regard to water quality, and it's great to see the program develop and grow and see the students interact with faculty and industry professionals,” Rieger said.

Rieger added that it is difficult to administer an interdisciplinary effort and praised Inamdar, who he said “has done a great job incorporating four colleges into the program.”

Rieger acknowledged the many UD alumni who were in attendance and taking part in the expert panel discussion. He said this speaks to the importance of building connections and networks at such events.

### Research presentations

Following the plenary talk, 15 UD water science and policy students gave five-minute presentations on their research, including topics such as “The Effect of In-Season Fertilization Strategy on the Yield and Nutrient Use Efficiency of Irrigated Corn” and “From Ridge Top to Valley Bottom: Soil Greenhouse Gas Fluxes Across Complex Terrain.”

The presentations were moderated by Alex Soroka, a master's degree student in CANR, and Matthew Miller, a doctoral student in the college, and student awards were handed out after the presentations.

First place went to Miller for his talk “Extreme Weather and Drinking Water Utilities: Impacts, Risks and Tough Decisions,” second place went to Chelsea Krieg for “After the Storm: Nitrogen Cycling in Flood Sediments and Impacts on Water Quality,” and third place went to Joe Brown for “A Field Study of Biochar Amended Soils.”

A panel discussion followed with panel members including:

- Jennifer Adkins, executive director, Partnership for the Delaware Estuary;
- Christina Casole, water resources engineer, Skelly and Loy Inc.;
- Ed Hallock, program administrator, Office of Drinking Water;
- Alison Kiliszek, engineer, Delaware Department of Natural Resources and Environmental Control (DNREC);
- Christopher Nealen, hydrologist, U.S. Geological Survey;
- Mark Strickland, water resource engineer, Century Engineering Inc.; and
- Larry Trout, senior manager, water resources, RK&K.

The panel was moderated by Sandra Petrakis, a master's degree student in CANR, and Matthew Miller.

The symposium wrapped up with informal networking and hors d'oeuvres in the Townsend Hall Commons.

Article by Adam Thomas

Photos by Wenbo Fan

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BUILDING A BETTER WORLD

## Job Title

# Associate Engineer/Planner/Scientist – Water Resources

## Description

At MWH, growing a great engineering, consulting and construction services company happens from the inside out. If working on the best water and natural resources projects, building your talents through knowledge sharing and connecting with top talent appeals to you, join us.

MWH Global...we're looking for opportunities.

MWH has an opening for an associate-level Engineer/Planner/Scientist who will contribute to developing and delivering world-class water resources solutions. This position will be based in our Sacramento office.

Sacramento provides MWH with an ideal location to support efforts of Federal, State, regional, and local water-related agencies/organizations to promote and apply water supply reliability, flood management, and environmental restoration strategies, from planning to implementation throughout California and the western U.S.

Responsibilities of this position include the following:

- » Gain and apply experience in California water resources including river systems/water-related infrastructure, applicable laws/policies/regulations, and understanding of operations of the Central Valley Project and State Water Project
- » Participate in multi-disciplinary teams on water resources projects throughout California and the western U.S.
- » Conduct technical evaluations supporting planning and design of water supply, flood control, and environmental restoration projects
- » Coordinate with project managers, project engineers and staff, clients, regulatory agencies, and subcontractors
- » Perform project administration including preparing reports, gathering information, drafting proposals, drafting correspondence, completing progress reports, and conducting project management
- » Perform other duties as assigned

## Qualifications

- » Engineer:
  - Bachelor's degree in civil/environmental engineering, water resources engineering, or related field; MS preferred
  - Valid California P.E. license, or ability to obtain one within 1 year of employment, is desired
- » Planner/Scientist:
  - Bachelor's degree in hydrology, geology, environmental science, ecology, natural resources, water resources planning, or related field; MS preferred
- » BS degree required, MS preferred, in civil or environmental engineering
- » 0-2 years of experience in one or more of the following:
  - Water allocation, reservoir operation, water system hydrologic and temperature models
  - Modeling the Sacramento-San Joaquin Delta
  - Development of criteria to evaluate system performance or ecosystem health
  - Engineering feasibility analyses and design
  - Hydrology and hydraulics
  - Surface water and groundwater systems
  - Integrated water management in relation to the dimensions of water (surface water and groundwater, and quantity and quality), interactions with land and the environment, and interrelationships with social and economic development
- » Excellent written and oral communication skills
- » Strong interpersonal abilities for working in diverse team environments with staff, clients, and stakeholders
- » PMP certification a plus



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