The Doctor of Philosophy degree in Hydrology and Water Resources requires a combination of:

- **Course Work** – Approved graduate-level course work for the MAJOR\(^1\) and the MINOR\(^2\)

- **Research and Scholarship** – A research-based Doctoral Dissertation

- **Professional Development** – Further enhancement of existing oral presentation skills by (1) enrollment in the departmental colloquium (a weekly colloquium with invited speakers who demonstrate professional oral presentation techniques for presenting scientific research) AND (2) presentation of a student’s own dissertation research at two approved national or regional conferences

Course Work is documented on the Doctoral Plan of Study (DPOS) and must include a minimum of 54 units in the MAJOR (this includes course work units plus dissertation units) and approximately 12 units in the MINOR (course work). At least one-half of the courses on the Plan of Study must be graded with regular grades (e.g. A, B, C). *The department does not permit the Grade Replacement Opportunity (GRO) for courses in the Major.* Of the 66 units required for the degree, at least 30 units must be completed at the University of Arizona. Total units for the doctoral degree include:

- 36 units of graduate-level course work for the MAJOR
  - Minimum of 18 units with Primary HWRS Faculty
  - Must include 2 units of HWRS Field Methods
- 18 units of HWRS 920 Doctoral Dissertation
- 12 units of graduate-level course work for the MINOR\(^2\)

Refer to the section on Transfer Course Work for details about course work for the Major and/or Minor areas of study. If a student wishes to include transfer course work in the Plan of Study, the Evaluation of Transfer Credit form must be submitted prior to the end of the first year in residence.

Research and Scholarship are satisfied by completion of a research-based Doctoral Dissertation and successfully defending the dissertation. This is documented by:

- Submission of the HWRS Dissertation Proposal in the third or fourth semester in residence
- Enrollment in a total of 18 units of HWRS 920 Dissertation, usually during the final semesters of residence

\(^1\) The Department does not allow the Grade Replacement Opportunity (GRO) option for any HWRS courses in the Major; however, your Minor department may permit GRO of course work for the Minor. Consult with your Minor Department. See the Graduate Catalog or Graduate College website for details about GRO.

\(^2\) Most, but not all, doctoral minors require 12 units. Some allow transfer units, some do not. Some require one or more specific courses, some do not. After choosing the Minor, we encourage you to contact a potential faculty advisor in your Minor department to learn more about specific requirements.
After enrollment in 18 units of 920 Dissertation, continuing enrollment status is maintained through Professional Development is satisfied by:

- Enrollment in HWR 695A (1 unit) Wednesday Weekly Colloquium for one semester during academic residency. Student may choose semester of enrollment, although enrollment should be completed prior to presenting dissertation research at national or regional conferences near the end of academic residency.
- Two presentations of dissertation research at approval national or regional conferences. The format of presentations may be (1) both oral papers or (2) one oral paper and one poster.

**MAJOR COURSE WORK = Take 36 UNITS (See categories and minimum requirements below)**

**FUNDAMENTALS: CORE COURSES**

A Doctoral student is not required to take fundamental core courses (often referred to as Master’s Core courses), although he or she may find them useful, particularly when preparing for the first-year Doctoral Oral Qualifying Examination. If your prior graduate degree was narrowly focused on one aspect of hydrology and water resources, we recommend you take one or more cores courses which will expand your educational background and increase your chance of success when sitting for the qualifying examination. These courses are not sequential and may be started in either Fall or Spring Semesters.

*No more than four Master’s level courses should be included in the plan of study.*

Courses offered in Fall:
- **HWRS 517A** Fundamentals: Water Quality (3) Meixner
- **HWRS 518** Fundamentals: Subsurface Hydrology (3) Ferre or Neuman
- **HWRS 575** Economic Evaluation of Water and Environmental Policy (3) Colby
- **HWRS 641** Water Law (3) Glennon - Permission to enroll and course registration through College of Law

Courses offered in Spring:
- **HWRS 519** Fundamentals: Surface Hydrology (3) Troch
- **HWRS 528** Fundamentals: Systems Approach Hydrologic Modeling (3) Gupta

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3 The Doctoral Oral Qualifying Examination must be completed by the end of the second semester in residence. The student must demonstrate a good general knowledge in at least three areas of concentration from among Surface Hydrology, Subsurface Hydrology, Water Quality-Chemistry, and Water Resources-Systems-Policy. A student may choose the three areas for examination but not the specific examiners. The department head will assign appropriate faculty members who represent the chosen areas, although one of the three members will be the student’s advisor who will serve as the Chair.
• **HWRS 576** Natural Resource Law and Economics (3) Cory

# HWRS ADVANCED COURSES

## PRIMARY FACULTY\(^4\) COURSE LIST

**18 UNITS MINIMUM\(^5\) FROM THIS CATEGORY**

Complete at least 18 units (six courses) from this category for inclusion in the DPOS.

All Primary Faculty courses, except those noted, use the prefix **HWRS**:  
- **517A, 518, 519, or 528**: From 0 (no minimum) to 4 (maximum) Core Courses from previous list
- **503** Subsurface Fluid Dynamics (3) Neuman
- **504** Numerical Methods Subsurface Hydrology (4) Neuman
- **505** Vadose Zone Hydrology (3) Ferré
- **516** Hydrologic Transport Processes (3) Yeh
- **521** Water Resources Systems Planning and Management (3) Valdés
- **524** Hydroclimatology (3) Niu
- **531** Hydrogeology (4) 3 units LEC & 1 unit LAB Zreda
- **532** Environmental Hydrogeo (3) 3-unit LAB Zreda
- **535** Advanced Subsurface Hydrology (3) Yeh
- **543A** Environmental Risk-Econ Analysis Water Res (3) Winter
- **549** Statistical Hydrology (3) Valdés
- **GEOS 553** Glacial and Quaternary Geology (3) *Exception to cross-listed rule; GEOS is home* Baker
- **570** Computer Simulation Water Quality Proc (3) Meixner
- **GC/HWRS 572** Global Biogeochemical Cycles (3) *Exception to cross-listed rule; GC is home* Leavitt
- **580** Isotope Tracers in Hydrogeology (3) McIntosh
- **582** Applied Groundwater Modeling (3) Maddock
- **596M** Application & Theory Decision Support Models (3) Washburne/Tidwell
- **602** Snow Hydrology (2)
- **603A** Well Hydraulics & Pumping Test Analysis (3) Yeh
- **630** Advanced Catchment Hydrology (3) Troch
- **642** Analysis of Hydrologic Systems (3) Gupta
- **645** Stochastic Methods Subsurface Hydro (3) Yeh

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\(^4\) Primary Faculty members are Baker, Ferré, Gupta, Maddock, McIntosh, Meixner, Niu, Troch, Valdés, Yeh, Winter, and Zreda. A “Primary” course is one in which the Primary Faculty teaching load is 50% or more. Courses with multiple instructors where less than 50% is taught by a Primary Faculty member are not included in the Primary Faculty list.

\(^5\) Independent study units may not be used in lieu of a 3-unit course except in cases where a course was canceled due to low enrollment and independent study units used in its place. Documentation is required.
• 655 Stochastic Methods Surface Hydro (3) Gupta/Valdés
• 696B Advanced Topics Hydrology-Biogeochemistry Interactions
• 696C Advanced Topics in Subsurface Hydrology and Modeling
• 696F Advanced Topics in Surface Hydrology and Modeling
• 696G Water-Rock-Microbial Interactions
• 696H Advanced Topics in Geochemistry of Crustal Fluids
• 696I Advanced Topics in Pore-Scale Processes
• 696L Topics in Semi-Arid Hydrology
• 696T Cosmogenic Isotopes and Other Environmental Tracers

CROSSTLISTED COURSES PRE-APPROVED FOR DPOS

You may include one or more of these courses on the DPOS without petition. Consult with your faculty advisor first. This is a graduate-level only course list: Courses listed in this category are taught only at the graduate level and are not co-convened at the 400- and 500-level. Courses are listed in numerical (not alphabetical) order.

ATMO/HWRS 529 Objective Analysis in Atmospheric and Related Sciences
ATMO/HWRS 558 Mesoscale Meteorological Modeling (3)
SWES/HWRS 566 Soil and Groundwater Remediation (3)
AREC/HWRS 577 Advanced Topics Economic Environmental Regulation (3)
PA/HWRS 581 Environmental Policy (3) *Exception to co-convened rule when taught separately (i.e. 481 Fall, 581 Spring)*
ATMO/HWRS 595B Global Climate Change Colloquium (3)
ATMO/HWRS 595C General Circulation Observations-Modeling (1-3)
SWES/HWRS/LAW 596B Arizona Water Policy (3) If enrolled as LAW, permission and registration through College of Law
GEOG/HWRS 596K Risk and Society (3)
SWES/HWRS 605 Soil-Water Dynamics (3)
SWES/HWRS 625 Physical Characterization in Monitoring the Critical Zone (3)
LAW 606 Constitutional Law I (3) Permission to enroll and register through College of Law
WSM/SWES 696M (3) MATLAB Data Processing
SWES/HWRS 696Q Practical and Applied Meteorology (1-3)

CO-CONVENED COURSES NOT PRE-APPROVED FOR DPOS

Courses listed below are not automatically approved for the DPOS without your faculty advisor’s consent. This list includes:

- Courses that may be crosslisted with HWRS but HWRS is not the Home Department
- Courses that are co-convened (i.e. taught at the 400- and 500-levels and include undergraduates—juniors and seniors—as well as graduate students)
A course on the following list is not automatically approved for inclusion in a Doctoral Plan of Study, regardless of whether it has been approved for another student. Plans of Study are highly individualized and may be based on prior educational, professional experience, or other criteria. Seek the advice of your faculty advisor and academic advisor if you wish to include one or more courses on your DPOS. NOTE: Depending on your choice of Minor, some of these courses may be used for the Minor rather than the Major; however, they cannot be used to fulfill requirements in for both categories. Courses are listed in numerical order, not alphabetical order.

- RNR 417-517 Geographic Information Systems for Natural and Social Sciences (3)
- CE/HWRS 423-523 Hydrology (3)
- CE/HWRS 427-527 Computer Applications in Hydraulics (3)
- ATMO/HWRS 436A-536A Fundamentals of Atmospheric Sciences (3)
- GEOS 439A-539A Introduction to Dendrochronology (4)
- GEOS 450-550 Geomorphology (4)
- WSM/HWRS 452-552 Dryland Ecohydrology and Vegetation Dynamics (3)
- WSM/HWRS 456A-556A Watersheds and Ecosystem Function (3)
- WSM/HWRS 460-560 Watershed Hydrology (3)
- SWES 464-564 Environmental Chemistry (3)
- WSM/HWRS 467-567 Advanced Watershed Hydrology (3)
- RNR/HWRS 473-573 Spatial Analysis and Modeling (3)
- GEOS/HWRS 478-578 Global Change (3)
- GEOG 483-583 Geographic Applications of Remote Sensing (3)
- REM/HWRS 490-590 Remote Sensing for Study of Planet Earth (3)

### FIELD METHODS = Take 2 UNITS

The HWRS field methods course is required for all students and may be satisfied as follows:

- HWRS 513A (2) Meixner/Ferré SPRING (starts in spring and officially ends early PRESESSION)
- A field camp experience in Geology does not routinely satisfy this requirement
- If requesting a review of prior field methods experience to be used to satisfy this requirement, submit a Letter of Petition requesting waiver of requirement (details follow)
  - Address to department head, submit to academic advisor
  - Petition review process used primarily by students with extensive field campaign experience through long-term employment in consulting or with a governmental agency (e.g. USGS, AZGS, EPA/DOE, USDA ARS, national laboratories)
  - Letter of Petition requires detailed documentation of prior experience or activities, description of job duties, skills, and current contact information for supervisor of prior field work
  - If approved, no academic credit awarded, no units awarded, no grade awarded
May need to replace unit(s) with other course work to meet unit requirements for your degree

MINOR COURSE WORK = TAKE x? UNITS (As prescribed by Minor Department)

Consult with your Minor Department regarding all requirements related to course work and assignment of faculty advisors in the minor. Some departments require two faculty advisors, others may require only one. Some departments may require one or more specific fundamental courses and allow you to choose the remaining courses from a list of electives. Some departments may allow you to transfer one or more courses from a prior graduate degree.

TRANSFER COURSE WORK FOR MAJOR AND/OR MINOR = x? UNITS

If appropriate, your faculty advisor may recommend that you include graduate-level course work completed at another institution in your DPOS. Ultimately, all requests for inclusion of transfer course work must be approved by the Department Head and the Graduate College Degree Certification office. This is accomplished by submitting an Evaluation for Transfer Credit form during the first or second semester in residence (prior to the Plan of Study).

- Consult the Graduate Catalog for rules regarding acceptance of course work. At the Graduate College homepage, follow links to “Policies and Procedures, Degree Requirements, Doctor of Philosophy, Credit Requirements and Transfer Credit”). Some restrictions apply and include, but are not limited to:
  - Actual number of units permitted to transfer within context of entire program
  - Course grade must be a regular quality-point grade (e.g. A or B or their equivalents); the Graduate College will convert based on information provided on your transcript, the WES scale, or official reference material
  - No courses graded as S (satisfactory) or P (pass) or without quality points that affect the GPA may be transferred
  - Course must not have been used in an undergraduate degree program, regardless of actual course level (i.e. cannot include a graduate-level course if it was used to meet a requirement for an undergraduate degree)
  - Course must not have been taken for correspondence or extension credit

- Prior to end of the first year of study, submit the Transfer Credit Evaluation form
  - Logon to GradPath in UAccess and select the form located at the bottom of screen
  - List any and all courses that you might consider transferring later on
  - This is a pre-approval process to determine eligibility for later inclusion in a Plan of Study
  - Do not recalculate or convert quarter units to semester units
  - Do not recalculate or convert numerical grades to letter grades
Do not attempt to convert your grade to a UA equivalent; the Graduate College will do this
o Submit the completed form to GradPath so that it can be evaluated by Graduate Student Academic Services (GSAS)

PROFESSIONAL DEVELOPMENT = Take 1 UNIT (do not include on DPOS)

You must enroll in HWRS 695A (1 unit), the Wednesday Weekly Colloquium, for one semester during academic residency. Do not include this unit on your Doctoral Plan of Study.

PROFESSIONAL DEVELOPMENT = Make 2 PRESENTATIONS

You must make two presentations at approved national or regional conferences. You may present (1) two oral paper presentations or (2) one oral paper presentation and one poster presentation. This requirement should be satisfied during the final year in residency after the dissertation research is well underway and nearly completed. Ask the academic advisor for a sample letter to use when requesting approval of your presentations.

DISSERTATION = Take 18 UNITS TOTAL

Enroll for your primary faculty supervisor’s individual section number of HWRS 920 Dissertation. Enrollment is available only through academic advisor’s office. You may enroll for as few as 3 units per semester or as many as 9 units per semester. HWRS 920 Dissertation units are graded at the end of academic residency when you have passed your Final Oral Examination (dissertation defense).