GOALS: The goals of Geography 446 are to provide an understanding and appreciation of water resources management policies and institutions. A major theme of the course is the applicability of the concept of unified river basin management for water and related land resources in pursuit of diverse public objectives. The course stresses interrelationships among watershed planning, relevant legislation, agency authority and coordination, and the geography of watershed management. The course focus is on U.S. water resources policy issues and institutions. The course also emphasizes linkages between environmental sciences and management/planning institutions, including such topics as aquatic ecology, wetlands, floodplain management, recreation, water supply, hydropower, and industry.

PREREQUISITE: Geo 226 Hydrology or consent of instructor.

TEXT: No standard text. Required reading includes research journal articles (see below).

ATTENDANCE: Attendance and participation in class are required. If you miss class, you are responsible for missed material and/or assignments. I understand reasonable absences—see me and I will help you get back up to date. Students with more than two (unexcused) absences may receive a lower grade for the course, regardless of their performance, at the instructor’s discretion.

Disturbance of class—including any distraction from cell phones—will not be tolerated. After one warning to the class, each instance of using a cell phone or other electronic device in class will result in the final course grade being lowered one letter grade, regardless of performance, at the instructor’s discretion. This is a tobacco-free classroom.

MAKE-UP EXAMS: If classes are cancelled on an exam day, the exam will be given the first class when classes resume. You are expected to take exams at the scheduled time. Only very unusual circumstances (e.g. family emergency, serious illness) are acceptable reasons for missing an exam. You MUST notify me prior to the exam time if you will miss an exam, IN ANY EVENT. Failure to notify me prior to a missed exam will result in a zero exam grade. Make up exams may differ from the original.
GRADING: Grades will be based on a minimum of 90% (A), 80% (B), 70% (C), 60% (D). Plus/minus grades may be given to scores ± 3% from these values.

<table>
<thead>
<tr>
<th>Undergraduate students</th>
<th>Graduate students</th>
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<tbody>
<tr>
<td>100 points</td>
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<tr>
<td>Mid-term exam</td>
<td>Mid-term exam</td>
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<td>100 points</td>
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<tr>
<td>Final exam</td>
<td>Final exam</td>
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<tr>
<td>50 points</td>
<td>50 points</td>
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<tr>
<td>Class participation</td>
<td>Class participation</td>
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<tr>
<td>150 points</td>
<td>150 points</td>
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<tr>
<td>Research project</td>
<td>Research project</td>
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<td>50 points</td>
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<tr>
<td>Presentation</td>
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<tr>
<td>400 points</td>
<td>450 points</td>
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<td>TOTAL</td>
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CLASS PARTICIPATION: You are expected to attend class prepared to contribute to discussion of required reading and lecture topics. For each journal article assigned, you must submit a short, original summary of the research objectives, methods, and conclusions as well as two or more questions or discussion points (typed document due on date of discussion, 30 total points). Additional class participation (up to 20 points) will be based on your contribution to classroom discussion:

Consistently provide thoughtful comments: 16-20 points
Usually well prepared, limited participation in discussion: 10-16 points
Frequent absences, poorly prepared, and/or rare participation: 0-10 points

HELP: The Learning Assistance Center (www.ship.edu/learning) provides professional aid for you to improve your studies. Of course, feel free to come to my office to ask questions about course matters as well.

NOTES: The instructor is willing to make reasonable accommodations for students with limitations due to disability, including learning disability. Please see me the first week of class to discuss any special needs you have. Also, any expected religious holiday absences must be provided to the professor in writing by January 25.

Shippensburg University faculty support a safe campus environment for all. No one on this campus has the right to threaten you or make you feel intimidated in any way. More specifically, unwanted advances, harassment, aggressive or violent behavior, and sexual assault will not be tolerated. A comprehensive list of reporting options and support services, including confidential resources, can be found at www.ship.edu/no_more/.
<table>
<thead>
<tr>
<th>Date</th>
<th>Topic / Case study</th>
<th>Reading</th>
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</thead>
<tbody>
<tr>
<td>Jan 23</td>
<td>Course introduction: <em>Watershed functions</em></td>
<td></td>
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<tr>
<td>Jan 30</td>
<td>Historical perspective on federal water legislation</td>
<td></td>
</tr>
<tr>
<td>Feb 1</td>
<td>Research Projects and bibliographic searches</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Case study: Shippsburg Borough Authority</em></td>
<td> Conodoguinet Creek TMDL General Info</td>
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<td></td>
<td></td>
<td> Zhang, Q, DC Brady, WR Boynton, and WP Ball. 2015. Long-Term Trends of Nutrients and Sediment from the Nontidal Chesapeake Watershed: An Assessment of Progress by River and Season. <em>JAWRA</em> 51(6):1534-1555.</td>
</tr>
<tr>
<td>Feb 22</td>
<td>Federal legislation: Clean Water Act</td>
<td></td>
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<tr>
<td>Mar 1</td>
<td>Federal legislation: ESA <em>Case study: Cedar River Watershed, WA</em></td>
<td></td>
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<tr>
<td>Mar 6</td>
<td>Catch up / Review</td>
<td></td>
</tr>
<tr>
<td>Mar 8</td>
<td>MID-TERM EXAM</td>
<td></td>
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<tr>
<td>Mar 11-19</td>
<td>SPRING BREAK – NO CLASS</td>
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<tr>
<td>Date</td>
<td>Topic / Case study</td>
<td>Reading</td>
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</table>
| Mar 20 | Water law: riparian rights  
Case study: *Sylvan Creek, WV*                  | ➢ Federal and tribal reserved water rights  
| Mar 22 | Water law: prior appropriation  
Case study: *Native American water rights*              | ➢ Federal and tribal reserved water rights  
| Mar 27 | Multi-state institutions  
| Mar 29 | Multi-state institutions  
| Apr 3  | State water legislation  
Case study: *Pennsylvania DEP*                         | ➢ PA DEP Wellhead Protection Program Overview  
| Apr 5  | Research project work day                             | ➢ PA DEP Wellhead Protection Program Overview  
| Apr 10 | State water legislation  
Case study: *Florida and Everglades restoration*      | ➢ PA DEP Wellhead Protection Program Overview  
| Apr 12 | Local water legislation:  
*Wellhead protection*                                    | ➢ PA DEP Wellhead Protection Program Overview  
| Apr 17 | Local water legislation:  
*Stormwater management*                                   | ➢ PA DEP Wellhead Protection Program Overview  
| Apr 19 | Adaptive management / integrated water resources management  
| Apr 24 | Water quality and watershed best management practices  
| Apr 26 | Field Trip:  
Burd Run restoration  
# Research projects

<table>
<thead>
<tr>
<th>Date</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 6</td>
<td>Topic approval due (10 points). Provide a detailed 1-page description of a well-focused topic <em>that we have discussed and approved</em>. Note that a few sentences are not sufficient. You should briefly describe the focus of the paper, study area, key sources of information (e.g. bodies of literature), any use of original or secondary data, and basic methods.</td>
</tr>
<tr>
<td>Feb 20</td>
<td>Bibliography due (40 points). Provide a listing of all references, including journal articles, agency reports, books, maps/spatial data, personal contacts, internet sites, and other media. <strong>A minimum of 10 (undergraduate) or 15 (graduate) peer-reviewed research journal articles is required.</strong> You must also include several other sources, such as agency documents, books, and other case study materials. See GEO-ESS writing resources for formatting references cited. <strong>There are no second chances on this assignment--ask questions before submitting your bibliography.</strong></td>
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<tr>
<td>Apr. 10</td>
<td>Written report due (100 points). See below for instructions. Be sure to meet bibliography requirements in your final report. Follow required GEO-ESS writing style.</td>
</tr>
<tr>
<td>May 3</td>
<td>Research presentations (50 points). See below for instructions.</td>
</tr>
</tbody>
</table>

Each student must complete a research project. All final written reports should be well organized, carefully written, and properly documented. Include a table of contents and use a hierarchy of headings and subheadings to organize the report (see outline on next page). Maps, figures, and tables are essential. You must include at least two original graphics that you prepare (e.g. Excel graphs, GIS maps, etc.) Proofreading and editing errors are unacceptable. **See G-ES Department webpage for writing resources.**

Research papers should address significant water resource issues within a watershed-based management framework. All papers must address relevant water management **institutions** (e.g. laws, policies, comprehensive plans, management agencies, etc.). Projects may vary considerably in terms of the emphasis of your work, including those based heavily on GIS, planning tools, hydrologic analysis, cost-benefit economics, etc. Final papers must be **less than 15 pages at 1.5 line spacing (20 pages for graduate students)**, not including abstract, table of contents, references, figures, or tables. You are encouraged to visit your study area, collect and analyze your own data, conduct personal interviews, etc.

Key steps in the research process:

- **Identify the water management issue(s) you will address.** There are many possibilities, including:
  - Non-point sources of pollution
  - Urban storm water management
  - Stream channel restoration
  - Treatment of acid mine drainage
  - Public water supply
  - Aquatic habitat quality / fisheries
  - Soil erosion and sedimentation
  - Flood control
  - Water-based recreation
  - Wetlands conservation
  - Critical aquifer recharge areas
  - Sustainable land use planning

- **Identify a watershed of reasonable size as a case study.** Any scale is acceptable, but watersheds smaller than counties often work best. Maintain a watershed-wide perspective in your research.

- **Conduct the literature review (see requirements of bibliography).** Note that *in addition to the scientific literature*, previous studies on your selected watershed are very useful, including:
  - Rivers Conservation Plans
  - Watershed Conservation Plans
  - Tributary Strategy Implementation Plans (Chesapeake 2000 agreement)
  - Pennsylvania Act 167 plans
  - Pennsylvania Act 537 plans
  - Agency reports (e.g. SRBC, DRBC, Act 220 State Water Plan, etc.)
Research projects should include the following sections.
Use more descriptive headings and adjust organization to suit your paper.
*See G-ES Department Webpage for Writing Resources: Style Guide, Formatting, Best Practices*

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>See GEO-ESS Style Guide</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>See GEO-ESS Style Guide</td>
</tr>
<tr>
<td>Introduction</td>
<td>Briefly summarize the purpose of the study. State why and where the study was conducted. Explain why the problem to be addressed is important and the benefits of this study (i.e., convince the reader why the issue matters). Explain the overall organization of the paper.</td>
</tr>
<tr>
<td>Purpose and scope</td>
<td>Explicitly define the research questions addressed by the study and limit the study in scope.</td>
</tr>
<tr>
<td>Study area</td>
<td>Limit the geographic extent of the study and describe the <em>relevant</em> characteristics of that area (water resource utilization, hydrology, geology, soils, vegetation, land use, economy, political and legal concerns, institutional context, etc.). Include maps whenever possible.</td>
</tr>
</tbody>
</table>
| Methods               | Explain the techniques used to collect, analyze, and display data or information. Data and results are not included here – only the methods should be described. For many projects, “literature review” will be the primary method, in that you are collecting and interpreting information from prior studies and interpreting that information with a particular research focus. You do not need to explain minor details, such as the bibliographic search techniques, but you should briefly describe the focus of the literature review within the context of your research questions. Other common research methods include:  
  * Key informant interviews (even if fairly informal – email or telephone)  
  * Descriptive statistical analysis (often of secondary data—from other studies), including mean, median, standard deviation, etc.  
  * Spatial data analysis, such as GIS or other map and aerial photo analysis  
  * Temporal analysis (trends over a period of time)  
  * Comparison of secondary data sets (e.g. examination of similar data from multiple prior studies)  
  * Field sampling to collect primary data (varies by study)  |
| Literature review     | See GEO-ESS Style Guide                                                                                                                                                                                     |
| Results and Discussion| Report the information (data) collected and the results of your analysis. You should interpret the data to directly address the research questions.                                                              |
| Conclusions           | Summarize the most important points, relating to previous studies (cited literature) and providing a succinct summary statement related to the main purpose of the study.                                             |
| References cited      | All references must be cited in the text and listed completely in the References Cited section. See GEO-ESS Style Guide and CSE Formatting Guide.                                                                  |
Basic pointers for writing the research paper

- Start with a clear purpose statement (“The purpose of this paper is to . . .”). You must be clear and specific in the beginning, stating what the paper will do--this lets the reader know what to expect.
- Avoid first person narrative (Yes: “Storm water management plans were reviewed…” No: “I reviewed storm water management plans…”)
- Avoid personal opinion—stick to objective interpretation of the facts.
- Tighten up writing as much as possible -- be concise. This takes multiple rounds of editing.
- Write out all contractions.
- Fully explain all acronyms the first time they are mentioned.

Common writing problems:

- site/ sight/ cite: Sight is vision, site is location and surroundings, you cite your references.
- effect/ affect: Effect is a noun, affect is a verb. An action affects something else, producing an effect.
- it’s/ its: It’s is a contraction that only means it is. (Write out contractions anyway.) We can say about a car that its color is red, without using an apostrophe.
- there/ their: There refers to place or time, or to introduce a clause or sentence (There are three apples there.). Their refers to people (They held their apples.).
- **PROOFREAD YOUR PAPERS**, which includes much more than just checking spelling--check grammar, punctuation, redundancy, etc.

Graduate Student Projects

Graduate student research projects are expected to provide a thorough review of literature relevant to the identified topic. The literature review may constitute a substantial part (e.g. 25-50%) of the final report. In addition, all graduate student projects must provide some “added value” beyond a review of the literature. For example, you might collect and analyze your own data, analyze previously collected data in new and innovative ways, provide a new spatial analysis of a problem (e.g. GIS), provide a meaningful update to previously conducted research, etc. The point is that you must conduct some original work beyond repackaging the science already available in published works. Feel free to discuss your ideas and this requirement with me.

Oral presentations

Each graduate student must present their research results in class. Undergraduate students who would like to present their results should discuss this option with me by February 20. Presenters MUST use visual aids (e.g. PowerPoint) and may NOT read presentations. Avoid excessive text on your presentation slides. Copies of your abstract should be distributed to the entire class. Handouts in addition to the abstract are encouraged. Further guidelines for the oral presentations will be provided.