

**Geology 513  
Hydrogeology  
Spring 2022 Syllabus**

**Meeting Time and Location**

Wednesdays 4:30–7:10 pm  
Exploratory Hall 1005

All classes are scheduled to be conducted in-person. If COVID or other issues prevent in-person classes, classes will be conducted synchronously on-line (i.e., live on-line) through Blackboard Collaborate Ultra. The Collaborate Ultra system may be accessed through the Tools menu on the course Blackboard page.

**Instructor**

Dr. Jules Goldspiel  
College of Science, Department of Atmospheric, Oceanic and Earth Sciences

e-mail: jgoldspi@gmu.edu (best contact method)

Office: Exploratory Hall 3414

Located in Exploratory Hall 3400 Office Suite (with Forensic Science Program offices)

Office Hours: Mondays 4:00 – 5:00 pm  
Other days and times by appointment

**Course Information**

3 Credits

Prerequisites: GEOL 101 (Introductory Geology I) or GGS 102 (Physical Geography)

MATH 113 (Analytic Geometry and Calculus I)

CHEM 211 (General Chemistry)

Or similar lab-science courses in each of Geology, Calculus and Chemistry

This course will focus on the geologic and hydrologic factors that control the occurrence, distribution, movement, quality and development of groundwater. In addition to the general properties that distinguish a groundwater system as an aquifer, this course will cover groundwater interactions with the surface, and how groundwater flow can be studied with computer models. Natural and engineered processes will both be discussed.

The goals of this course are for students to:

- Appreciate the range of physical and chemical properties common in groundwater systems
- Understand how surface conditions affect groundwater systems and vice versa
- Understand the principles of groundwater flow, and how flow is characterized and calculated
- Understand the practical issues related to aquifer development and depletion
- Understand the basic processes of aquifer contamination and remediation
- Gain experience with some of the tools and resources used to monitor, study and understand groundwater systems

Computer modeling will be part of the course. University computers will be available for students to participate in the modeling exercises, but students may also use their own computers. Computers running the Microsoft Windows operating system are best suited for the modeling exercises. Students will also find it helpful to have ready access to a scientific calculator, spreadsheet program or other method for calculations. Please talk to instructor if access to any of these tools may be a problem.

**Course Textbook**

*Applied Hydrogeology*, 5<sup>th</sup> Edition, 2022, C.W. Fetter and D. Kreamer, Waveland Press (Recommended)

### Other Useful General References

- Alley, W. M., et al., 1999, Sustainability of ground-water resources, USGS Circular 1186.  
(Available at <https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf> )
- Ferris, J. G., et al., 1962, Theory of aquifer tests, USGS Water-Supply Paper 1536-E.  
(Available at [https://pubs.usgs.gov/wsp/wsp1536-E/pdf/wsp\\_1536-E.pdf](https://pubs.usgs.gov/wsp/wsp1536-E/pdf/wsp_1536-E.pdf) )
- Hem, J. D., 1985, Study and interpretation of the chemical characteristics of natural water, 3<sup>rd</sup> Edition, USGS Water-Supply Paper 2254.  
(Available at <https://pubs.usgs.gov/wsp/wsp2254/pdf/wsp2254a.pdf> )
- Winter, T.C., et al., 1998, Ground water and surface water: A single resource, USGS Circular 1139.  
(Available at <https://pubs.usgs.gov/circ/circ1139/pdf/circ1139.pdf> )

### Required Coursework & Grading Weights

| Weight | GEOL 513 Coursework            |
|--------|--------------------------------|
| 15%    | Homework (5 assignments total) |
| 15%    | Semester Exercise              |
| 5%     | Semester Exercise Abstract     |
| 10%    | Numerical Model Inputs Summary |
| 15%    | Preliminary Exam I             |
| 15%    | Preliminary Exam II            |
| 25%    | Final Exam                     |

Homework assignments will generally involve calculations and/or basic computer modeling. Calculators, spreadsheets or other computational programs may be used, but intermediate steps and calculation methods must be shown.

The Semester Exercise will involve collecting and summarizing groundwater data. The data will be gathered from USGS websites. GEOL 513 students are further required to formalize the data summaries in the form of short abstracts.

The Numerical Model Inputs Summary assignment will involve collecting and summarizing the geologic and hydrogeologic properties for a specific region of the U.S. The end result is to be a summary table that contains all the basic information necessary to permit realistic modeling of groundwater flow in the region. The modeling itself is not required for this assignment.

### Grade Scale

- A     $\geq 90\%$       Letter grades will be determined by the weighted percentage of total points possible,  
B     $\geq 80\%$       with point values weighted as indicated in the table above. The grade scale is subject to  
C     $\geq 70\%$       change if the class mean is lower than expected, but any such change would be more  
D     $\geq 60\%$       favorable to students, i.e., the cutoffs for each grade could be at lower percentages  
F     $< 60\%$       than indicated by this scale but they will not be higher.

Letter grade +/- qualifiers will be used for grades near the letter grade limits.

## Tentative Course Schedule

| Week | Date  | Topic  | Homework |     |
|------|-------|--|----------|-----|
|      |       |  | Assigned | Due |
| 1    | 01/26 | Hydrogeology Overview<br>(Fetter and Kreamer: Chapters 1, 2.1-2.7)   |          |     |
| 2    | 02/02 | Physical Properties and Environments of Groundwater<br>(Fetter and Kreamer: Chapters 3, 12.1–12.2)   | #1       |     |
| 3    | 02/09 | Chemical Properties and Environments of Groundwater<br>(Fetter and Kreamer: Chapter 9)   | #2       | #1  |
| 4    | 02/16 | Hydrologic Connections Between Groundwater and Surface Water<br>(Fetter and Kreamer: Chapters 2.8-2.14, 6)   |          | #2  |
| 5    | 02/23 | Geologic Controls and Impacts of Groundwater Flow and Storage<br>(Fetter and Kreamer: Chapter 8)   |          |     |
| 6    | 03/02 | <i>Preliminary Exam I</i>  |          |     |
| 7    | 03/09 | Groundwater Flow: Governing Equations and Approximations<br>(Fetter and Kreamer: Chapter 4)  | #3       |     |
| 8    | 03/16 | <i>Spring Break – No Class</i>   |          |     |
| 9    | 03/23 | Groundwater Flow: Wells<br>(Fetter and Kreamer: Chapter 5)   |          | #3  |
| 10   | 03/30 | ❖ Groundwater Flow: Regional Systems<br>(Fetter and Kreamer: Chapter 7)  | #4       |     |
| 11   | 04/06 | Aquifer Protection, Contamination and Restoration<br>(Fetter and Kreamer: Chapters 10, 11.7-11.8)  | #5       | #4  |
| 12   | 04/13 | ■ Hydrogeology in Especially Wet, Dry and/or Cold Environments<br>(Fetter and Kreamer: Chapters 7.7, 8.5-8.6)  |          | #5  |
| 13   | 04/20 | <i>Preliminary Exam II</i>   |          |     |
| 14   | 04/27 | Numerical Modeling: General Principles, Mechanics & Applications<br>(Fetter and Kreamer: Chapter 13)   |          |     |
| 15   | 05/04 | To Be Determined (Possible options: Course Review, Groundwater Rights, Hydrogeology in Planetary Environments, expansion of previous topic and/or other topic) |          |     |
| 16   | 05/11 | * <i>Final Exam (4:30-7:15 pm)</i>   |          |     |

❖ Numerical Model Inputs Summary due

■ Semester Exercise and associated Abstracts due

\* If GMU is closed or inaccessible, the make-up date and time for the Final Exam will be announced. Check Blackboard and GMU e-mail.

Note: Course content and schedule may be modified by the instructor as the semester progresses.

### Other Important Dates

Jan 31 Last day to add classes

Feb 07 1<sup>st</sup> Drop deadline (full tuition refund, no record on transcript)

Feb 14 2<sup>nd</sup> Drop deadline (50% tuition refund, no record on transcript)

Mar 01 Last day for unrestricted Self-Withdrawal (W on transcript) [available to undergrads only]

Apr 11 Last day for Selective Withdrawal (W on transcript) [available to undergrads only]

After the 2<sup>nd</sup> Drop deadline, withdrawals for graduate students require academic dean approval.

## Course Policies

Electronic Devices: The use of electronic devices (computer, tablet, phone and the like) is permitted during class. While in class, your phone ringer and any other audible alerts on your devices must be off. Be respectful of your peers and instructor and do not use your electronic devices to engage in activities that are unrelated to the class while class is in session. The instructor reserves the right to prohibit the use of electronic devices by any student whose use of a device is disruptive to the class.

You may use University computers as part of the required work in this course. All standard University policies apply to the use of University computers and University computer systems for this course. Please see the GMU policies website (<https://universitypolicy.gmu.edu/policies/responsible-use-of-computing/>) for a summary of the University computer policies.

Calculators are the only aid that may be used during exams. If you plan to use a calculator function on a phone, tablet or other electronic device during an exam, you may only use the calculator function. Except for taking on-line exams themselves in the event the class transitions to on-line, no other use of electronic devices is allowed during exams, i.e., you may not use electronic devices to access notes or any other outside information during exams.

Course Materials and Presentations: All course materials and presentations (e.g., instructor notes, lectures, lecture outlines, lecture charts, assignments, exams, demonstrations) are for course use only. *They may not be shared, posted or in any way redistributed outside of the course, either electronically or as hardcopy.* Sharing or redistribution of these materials is a violation of the GMU Honor Code.

Recording of Lectures: Lectures and demonstrations may *not* be electronically recorded without prior permission of instructor and completion of the appropriate University Recording/Lecture Notes Agreement form. The opinions, questions or comments of other class members must not be played back to anyone outside of the class.

Attendance: Students are expected to attend class regularly, but attendance is not strictly required.

Assignments: Homework assignments will be posted on Blackboard on the days listed in the course schedule. Except when specifically noted, homework assignments are due by the start of class (4:30 pm) one week after they are issued. Assignments may be given to instructor directly, e-mailed to the instructor, or submitted through the on-line system specified in the assignment if that option is made available. *Please do not leave assignments in the instructor's office mailbox, and please do not leave them at the instructor's office if the instructor is not present at the time.*

Exams: The two Preliminary Exams will be taken during the regular class meeting time on the days listed in the course schedule. The time and day for the Final Exam is as listed on the course schedule. All exams are closed book and closed notes, and use of any other outside information is prohibited. All exams will be taken in-person unless the class transitions to on-line, in which case the exams will be taken on-line.

Late Assignments and Missed Exams: Reasonable accommodations will be made for late assignments and missed exams due to sickness, religious observance and other unavoidable schedule conflicts if the instructor is notified prior to the date the assignment is due or exam given. Unusual situations that prevent advance notice to the instructor will be handled on a case-by-case basis. In any event, assignments and exams that are not turned in, are not made up, or remain unexcused one week after the scheduled due date or exam date are subject to a grade of zero.

Collaboration: Students are encouraged to discuss with each other the information and concepts covered in the lectures and course readings. Collaboration on homework assignments, the Semester Exercise and Model Inputs Summary is permitted so long as all students in the collaboration fully participate in the discussion of all questions, do a fair share of the collaborative work, use different data sets, and do their

own write-ups. Simple division of labor (i.e., dividing questions within the group) is not consistent with this collaboration policy.

Any discussions and collaborations must be done in accord with all University and local authority COVID-19 protocols, policies and regulations. For more information on health and safety protocols, see GMU's Safe Return to Campus website: <https://www.gmu.edu/safe-return-campus> .

Collaboration of any sort is not permitted during exams.

Grade Postings on Blackboard: Your assignment and exam scores will be posted on Blackboard unless otherwise requested. Please tell the instructor if you do not want your scores posted on Blackboard.

Unscheduled University Closure: In the event of an unscheduled University closure or access limitation due to weather or other reasons, check Blackboard and your GMU e-mail for any class announcements. If class cannot meet because of a closure or access limitations, supplementary activities may be assigned.

### **University Policies**

General University Policies: The University Catalog is the central resource for GMU policies affecting student, faculty and staff conduct in university academic affairs. Please see the catalog (<https://catalog.gmu.edu>) or the University Policy web site (<https://universitypolicy.gmu.edu>) for information on academic and non-academic policies not explicitly specified in the syllabus.

Academic Integrity: GMU is an Honor Code university; please see the Office of Academic Integrity (<https://oai.gmu.edu>) for a full description of the code and the honor committee process. The principle of academic integrity is taken seriously and violations are treated gravely. Three fundamental principles to follow at all times are: (1) collaboration on coursework may or may not be permitted (see policies for specific courses), but either way all work submitted must be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules for collaboration on a particular assignment, ask for clarification. Another aspect of academic integrity is the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives and traditions.

Electronic Communications: The instructor will only use the GMU e-mail or the Blackboard systems for electronic communications with students. To make such communications easier, it is requested that all student electronic communications to the instructor be sent through your GMU e-mail account or through Blackboard. Please do not use personal e-mail accounts. For more information about student e-mail accounts, please see the GMU mail website (<https://mail.gmu.edu>).

Disability Accommodations: All academic accommodations must be arranged through Disability Services. If you need academic accommodations, please contact Disability Services at 703-993-2474 or talk to the instructor. See also the Disability Services web site (<https://ds.gmu.edu>) for more information.

Diversity: Through its curriculum, programs, policies, procedures, services and resources, GMU strives to maintain a quality environment for work, study and personal growth. An emphasis upon diversity and inclusion throughout the campus community is essential to achieve these goals.

Diversity is broadly defined to include such characteristics as, but not limited to, race, ethnicity, gender, religion, age, disability and sexual orientation. Diversity also entails different viewpoints, philosophies and perspectives. Attention to these aspects of diversity will help promote a culture of inclusion and belonging, and an environment where diverse opinions, backgrounds and practices have the opportunity to be voiced, heard and respected.

Sexual Misconduct and Interpersonal Violence: GMU is committed to providing a safe learning, living and working environment. Your experience at Mason is meant to be vibrant and dynamic, and one that

includes ample opportunities for exploration of self, identity and independence. Sexual misconduct and incidents of interpersonal violence deeply interrupt that experience, and GMU is committed to maintaining a campus that is free of such incidents.

GMU encourages individuals who have been sexually harassed, assaulted or subjected to sexual misconduct to seek assistance and support. Confidential resources that are available on campus include: University Title IX Coordinator, Counseling and Psychological Services (CAPS), Student Support and Advocacy Center (SSAC), and Student Health Services (SHS). Please note that most all other members of the University community are not considered confidential resources and are required to report incidents of sexual misconduct or other prohibited conduct to the University Title IX Coordinator.

### **Title IX**

Title IX is a federal civil rights law that was passed as part of the Education Amendments of 1972. It prohibits discrimination on the basis of sex under any education program or activity receiving federal funding. GMU receives federal funds in many forms and so is required to comply with Title IX.

Sexual assault and sexual harassment are forms of sex discrimination prohibited by Title IX. Other issues that are investigated under Title IX include stalking, intimate partner violence, gender-based harassment, sexual exploitation, complicity and retaliation for good faith reporting of any of these forms of conduct or participation in any investigation or proceeding.

For more information see <https://diversity.gmu.edu/title-ix/what-title-ix/university-title-ix-statement> and [https://www2.ed.gov/about/offices/list/ocr/docs/tix\\_dis.html](https://www2.ed.gov/about/offices/list/ocr/docs/tix_dis.html).

### **Student Support Resources**

GMU has several support resources available to all students. Potentially useful starting points for more information include:

- Learning Services: <https://learningservices.gmu.edu>
- Tutoring Resources: <https://learningservices.gmu.edu/tutoring-resources>
- Student Health Services: <https://shs.gmu.edu>
- Counseling and Psychological Services: <https://caps.gmu.edu>
- Student Support and Advocacy Center: <https://ssac.gmu.edu>
- Diversity, Equity and Inclusion: <https://diversity.gmu.edu>
- Sexual Misconduct, Harassment and Discrimination resources: <https://diversity.gmu.edu/title-ix>
- University Title IX Coordinator: <https://diversity.gmu.edu/title-ix/who-can-i-call>
- University Career Services: <https://careers.gmu.edu>

Many other resources listed under Student Life: <https://www.gmu.edu/student-life>

### **Coronavirus/COVID-19 Information and Resources**

COVID-19 remains a potential threat to the normal operations of classes and other activities at GMU this semester. Please pay attention to announcements regarding changes that may have to be made to this and other classes as conditions warrant.

GMU maintains a website with information and resources related to the coronavirus and the associated procedures and changes in GMU operations that are in response to the virus. The site is updated regularly with new data and information. It also contains links to external sites (i.e., outside of GMU) where additional information can be found (<https://www.gmu.edu/safe-return-campus>).

Mason COVID Health Check Requirements: All students taking courses with a face-to-face component are required to follow the University's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (<https://www.gmu.edu/safe-return-campus>). This includes

completing the Mason COVID Health Check every day. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red result. Only students who receive a “green” result are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green result for the day and are thereby permitted to be in class. If this policy changes, you will be informed.

Facemask Requirements: Students are required to follow Mason's current policy about facemask-wearing. As of January 17, 2022, all community members are required to wear a facemask in all indoor settings, including classrooms and vehicles, even if you are vaccinated unless Disability Services has approved an individual accommodation for you. An appropriate facemask must cover your nose and mouth at all times in the classroom (see <https://www.gmu.edu/safe-return-campus/personal-and-public-health/face-coverings>). If this policy changes, you will be informed.