I. COURSE INFORMATION

Department: Geosciences                        Course Number: GEO 103N

Course Title: Introduction to Environmental Geology
Lab Status: Without Lab

Type of Request: New

Rationale: The development of a freshman-level general education lecture course in Environmental Geology (GEO 103N) with a companion laboratory course (GEO 104N) will provide students access to an applied, broadly based introductory Geoscience course sequence that focuses on Earth-human interactions. Our existing GEO 101N/102N sequence (Introduction to Physical Geology/Laboratory) focuses on Earth materials and processes. GEO 103N, a 3 credit lecture course, provides a basic introduction to the principles of environmental geology and focuses on the development of elementary scientific skills through topical exploration of the interactions of humans with the Earth’s natural physical systems and a field exercise. No prerequisites are required.

These proposed new classes will provide a core course sequence for Geosciences students who have a strong interest in water science and the environment. This request to add GEO 103N Introduction to Environmental Geology (as well as GEO 104N Introduction to Environmental Geology laboratory) is part of a continuing departmental effort to (1) provide consistent instruction in a broad range of geoscience principles to all interested students; (2) optimize undergraduate course offerings; (3) better balance instructional offerings between the department’s two focus/research areas: water science and solid earth science; and (4) present courses that offer innovative and forward-looking content.

These two courses will serve as part of one of two general introductory foundation course options to undergraduates who elect to complete a major or minor in Geosciences. Students can elect to take either the GEO 103N/104N or the GEO 101N/102N sequence plus GEO 211 for a total of 8 credits. Students need complete only one of the lower division core options as part of their BS degree major or minor requirements, maintaining the credits required for the major at 62 and minor at 18.

*If course has not changed since the last review and is taught by the same tenure-track faculty member, you may skip sections III-V.

JUSTIFICATION FOR COURSE LEVEL

This 3-credit course provides a basic introduction to the study of environmental geology and focuses on the development of elementary scientific skills through topical exploration of the interactions between humans and Earth’s natural geologic systems. No prerequisites are required.

ADDITIONAL INFORMATION (FOR OCHE DATABASE):

In which MUS Core Category does this course fit? Natural Sciences
Does the course include content regarding cultural heritage of American Indians? No
II. ENDORSEMENT / APPROVALS

* Instructor: Marc S. Hendrix

Signature ___________________ Date ____________

Phone / Email: 406-544-0780/marc.hendrix@umontana.edu

Program Chair: James R. Staub

Signature ___________________ Date ____________

Dean: Christopher Comer

Signature ___________________ Date ____________

*Form must be completed by the instructor who will be teaching the course. If the instructor of the course changes before the next review, the new instructor must be provided with a copy of the form prior to teaching the course.

III. DESCRIPTION AND PURPOSE

General Education courses must be introductory and foundational within the offering department or within the General Education Group. They must emphasize breadth, context, and connectedness; and relate course content to students’ future lives: See Preamble

GEO103N – Introduction to Environmental Geology is a new general education natural science course offering that focuses on using geological thinking and the scientific process to recognize and address the impacts of geologic change on human society. This course provides a broad introduction to Earth’s geological processes, the timeframes over which they operate, and the techniques utilized to understand and measure geologic processes in the context of their impact on humans. Selected topics that will be covered include earthquakes; volcanoes; climate; tectonics; water and air pollution; water, energy, and soil resources; landslides and other forms of mass movement; and groundwater.

This course differs substantially from GEO101 (Introduction to Physical Geology) in that it emphasizes the quantification and understanding of Earth processes and how these impact human activities, rather than focusing solely on the processes themselves. As an introductory applied geoscience course, GEO103N will provide students with the tools to recognize and understand basic Earth’s processes, while also introducing them to some of the engineered solutions mitigating the impacts of these processes on humans. This course directly addresses numerous topics that will be of concern to humans seeking to live sustainably in Earth’s dynamic geologic environment.

IV. CRITERIA

BRIEFLY EXPLAIN HOW THIS COURSE MEETS THE CRITERIA FOR THE GROUP.

1. Courses explore a discipline in the natural sciences and demonstrate how the scientific method is used within the discipline to draw scientific conclusions:

   Environmental geology is the application of geologic analysis to problems involving interactions between humans and Earth. The scientific method is introduced at the beginning of the course, and it is the framework through which course topics are investigated. For example, in the discussion on volcanic hazards, modern methods of experimental design, data analysis, and interpretation of results are covered including applications involving geodesy, analysis of discharged volatiles, and seismic monitoring. Similarly, the scientific discovery and subsequent analysis of heavy metal contaminants associated with the Upper Clark Fork River Superfund Site will be featured both in class lectures and in a Saturday field trip.

2. Courses address the concept of analytic uncertainty and the rigorous process required to take an idea to a hypothesis and then to a validated scientific theory:

   The concept of analytic uncertainty will be discussed through multiple topical applications in environmental geology, including uncertainty associated with 1) measurements of pollutant concentrations by various methods (e.g., GC-MS, ICP-MS); 2) measurements of atmospheric pCO2 over historic and geologic time frames; 3) measurements of flow discharge during flooding events; 4) measurements of soil saturation in landslide-prone regions, and 5) measurements of wave and tidal energy on urbanized coastlines.
3. Lab courses engage students in inquiry-based learning activities where they formulate a hypothesis, design an experiment to test the hypothesis, and collect, interpret, and present the data to support their conclusions.

Most students in this class will also take the companion one-credit laboratory GEO104N 'Introduction to Environmental Geology Laboratory' which involves weekly inquiry-based learning activities in environmental geology.

Students in the GEO103N course will engage in inquiry-based learning through weekly lectures/class discussions and through a Saturday field trip in which they will undertake a laboratory exercise that requires inquiry-based learning. For example, in the class discussions involving volcanic hazards, volcanic explosivity will be investigated first by formulating a hypothesis regarding the causes of explosivity, followed by the collection of data through readings and lectures, followed by evaluation of the hypothesis near the end of the class discussion.

The Saturday field trip will involve observation of the Upper Clark Fork Superfund site (Milltown to Butte). Prior to the field trip, students will be asked to develop hypotheses as to the source of the heavy metals present and the mechanisms by which they were concentrated at the sites of greatest impact within the upper Clark Fork drainage. On the field trip, students will make observations related to landforms, engineered modifications to the Clark Fork River, and the results of heavy metals contamination, using these data to test their hypotheses and modify them if needed.

V. STUDENT LEARNING GOALS

BRIEFLY EXPLAIN HOW THIS COURSE WILL MEET THE APPLICABLE LEARNING GOALS.

1. Understand the general principles associated with the discipline(s) studied.

Students will be introduced to the course content through lecture, class discussion, a field trip, textbook reading, and assigned reading outside the textbook. At the beginning of each class, three iclicker questions will be asked that will directly assess the degree to which course content recently covered has been assimilated by the students. Starting with the second week, up to three iclicker questions per week will be recycled from a prior iclicker question set to evaluate how well students are assimilating and retaining the class content.

2. Understand the methodology and activities scientists use to gather, validate and interpret data related to natural process.

Students will be introduced to a wide variety of scientific methods used to measure Earth's processes over historic and geologic time frames. For example, the discussions of earthquakes will cover the methods used to measure seismic moment and locate the earthquake epicenter. Similarly, students will be introduced to a wide variety of methods used to quantify climate change over geologic time frames and those methods used to quantify climate change over historic time frames.

3. Detect patterns, draw conclusions, develop conjectures and hypotheses, and test them by appropriate means and experiments.

Students will undertake these scientifically-framed activities through through class discussion and through the Saturday field trip. For example, in lecture we will explore relationships among magma chemistry, volcanic explosivity and landforms, and volcanic hazards. In another example, we will examine regional records of seismic intensity for a historic earthquake, develop ideas as to what controlled that distribution, then test and revise that hypothesis by examining surficial geologic maps of the affected area. During the field trip, students will gather data relative to the distribution of heavy metals contamination within the upper Clark Fork River drainage and use these data to test a set of pre-trip hypotheses they will develop for identifying the sources and transport mechanisms of the contaminants.

4. Understand how scientific laws and theories are verified by quantitative measurement, scientific observation, and logical/critical reasoning.

Students will explore the application of scientific reasoning, including hypothesis-testing through measurement and interpretation to environmental geology. Specific examples include: 1) development of the Theory of Plate Tectonics through integration and interpretation of various observational platforms that include the fossil record, ocean floor magnetic patterns,
distribution of modern earthquakes and volcanism, geochronology, and modern day geodesy. 2) recognition of submergent vs. emergent coastlines by integrating observations of land form morphology, uplift/subsidence rates, and nearshore sedimentation dynamics.

5. Understand the means by which analytic uncertainty is quantified and expressed in the natural sciences.

Analytic uncertainty will be introduced as a stand-alone topic in lecture and explored in class discussions of quantitative measurements in the context of environmental geology. For example, in discussions of heavy metals pollution, analytic uncertainty associated with heavy metals concentration measurements of soil and water samples will be explored. Similarly, in class discussions focusing on the rates of plate tectonic movement, analytic uncertainty will be discussed in the context of geodetic measurements.

VI. ASSESSMENT

A. HOW ARE THE LEARNING GOALS FOR THE GENERAL EDUCATION GROUP MEASURED?

Describe how you will determine that students have met each of the General Education Learning Goals. This should include specific examples of assignments, rubrics or test questions that directly measure the General Education learning goals. (See Example)

Please attach or provide a web link to relevant assessment materials.

6. Understand the general principles associated with the discipline(s) studied.

The general principles covered in this class will be assessed in four ways:

1.) At the beginning of the semester, students will be asked to complete a questionnaire focusing on basic concepts that will be covered in class. The same questionnaire will be given to the students during the final day of class as part of the class evaluations. The difference in results from pre-to post-class will form part of the course summative assessment.

2.) During each class period, three iclicker questions pertaining to material already covered will be posed. Following each iclicker session, the answers to each question will be reviewed and discussed briefly as a class. Beginning with the second week of the semester, three iclicker questions that students had done poorly on in a previous week will be asked again as part of that week’s iclicker question set. The difference between the two aggregate responses will form the basis for the assessment.

3.) The course will involve an all-day Saturday field trip geared towards providing a deeper understanding of environmental geology through the on-site inspection and analysis of local field sites. The field trip also will be developed as an assessment tool. Prior to the trip, students will be asked to complete a questionnaire aimed at evaluating their familiarity with the field trip environmental geology topics. The trip itself will involve a worksheet exercise that the students will have to complete in the field for this portion of class credit. Following the field trip, students will be directed to complete a post-trip questionnaire geared towards assessing the extent to which learning outcomes from the field trip were successful.

4.) General principles in this class also will be assessed ‘for credit’ through the two midterm and final exams, the iclicker questions, and the field trip worksheets.

7. Understand the methodology and activities scientists use to gather, validate and interpret data related to natural process.

The scientific method and its application to natural processes will be addressed in the context of environmental geology. Specific examples include: a) through lecture and class discussion, students will explore the means by which pre-historic climate proxy data are extracted from sediment cores and how the temporal and spatial distribution of these data improve the resolution of global and regional climate models. b) through lecture, class discussion, and the field trip, students will explore the geologic setting and history of the science behind the establishment and remediation of the Upper Clark Fork Basin Superfund Site, including the collection and analysis of heavy metals data. c) through lecture, class discussion, and the field trip, students will study the removal of the Milltown Dam from the standpoint of metals remediation, geomorphologic change, and sediment transport dynamics.
Each of these three specific examples will be assessed using the four methods described above in part 6.

8. **Detect patterns, draw conclusions, develop conjectures and hypotheses, and test them by appropriate means and experiments.**

Pattern detection and integration into hypothesis-testing will be addressed across a wide variety of class topics. For example, relationships among volcanic landforms, magma chemistry, and resulting hazards will be covered in class lectures, class reading, and class iclicker questions. In addition, during the class field trip, students will be required to detect patterns and develop testable hypotheses. Students will be introduced to the Upper Clark Fork Superfund Site first through lecture, where they will be asked to formulate a set of hypotheses identifying the source and explaining the mechanisms by which metals were transported to and accumulated at the sites of greatest impact. During the trip, students will make observations related to landforms, engineered modifications to the Clark Fork River, and the results of heavy metals contamination and they will use these field data to test their original hypotheses regarding the source of the metals and the mechanisms by which they accumulated in the Upper Clark Fork River corridor.

Each of these three specific examples will be assessed using the four methods described above in part 6.

9. **Understand how scientific laws and theories are verified by quantitative measurement, scientific observation, and logical/critical reasoning.**

Class discussions and assigned reading pertaining to the Theory of Plate Tectonics will explore the development and refinement of the tectonic model as a physical and temporal framework for understanding issues of environmental geology. For example, class discussions of coastal processes will be cast in a sequence stratigraphic framework in which dynamics of erosion, deposition, and sediment transport are considered over geologic time frames and as a function not only of direct human interactions (sea wall construction, engineered groins, etc.) but also as a function of geologic processes such as base level change.

Assessment pertaining to how well students are retaining class material on the scientific process will be conducted through the pre- and post-class environmental geology questionnaires, the in-class iclicker questions and ensuing discussion, the field trip, and the class exams.

10. **Understand the means by which analytic uncertainty is quantified and expressed in the natural sciences.**

A wide variety of measurement units will be introduced and discussed in this class in the context of analytic uncertainty in environmental geology. Specific examples include the resolution of the geologic record, the directions and velocity of plate movements, the physio-chemical properties of eruptive magmas, and the prediction of floods.

The concept of analytic uncertainty and how it is integrated into the scientific methods will be assessed through the pre- and post-class environmental geology questionnaires, the in-class iclicker questions and ensuing discussion, the field trip, and the class exams.

**A General Education Assessment Report will be due on a four-year rotating cycle.** You will be notified in advance of the due date. This will serve to fulfill the University's accreditation requirements to assess general education and will provide an opportunity to connect with your colleagues across campus and share teaching strategies. Items VI.B- D will be helpful in compiling the report.

**B. ACHIEVEMENT TARGETS**

[This section is optional. Achievement targets can be reported if they have been established.]

Describe the desirable level of performance for your students, and the percentage of students you expected to achieve this:
1. Pre- vs. post-class questionnaires: I anticipate a 75% improvement rate between the pre- and post-class questionnaires.

2. iclicker questions: Achievement targets using the iclicker to assess class retention will involve the comparison of the same question posed twice over a period of 2-5 weeks. Of the 15 iclicker questions offered each week, 3 will be 'recycled' from an earlier iclicker question set and will be a question that many students missed. Early in the semester, the same questions will be posed over consecutive weeks. As the semester progresses, more time will be allowed to elapse between the two posing of the question in order to investigate this impact on student content retention. Initial achievement targets for retention of iclicker questions is 50% across the class (i.e., the number of students who missed the question the first time will be cut in half the second time the question is asked.)

C. ASSESSMENT FINDINGS

[This section is optional. Assessment findings can be reported if they are available.]

What were the results/findings, and what is your interpretation/analysis of the data? (Please be detailed, using specific numbers/percentages when possible. Qualitative discussion of themes provided in student feedback can also be reported. Do NOT use course grades or overall scores on a test/essay. The most useful data indicates where students' performance was stronger and where it was weaker. Feel free to attach charts/tables if desired.)

D. ASSESSMENT FEEDBACK

[This section is optional. Assessment feedback can be reported if it is available.]

Given your students’ performance the last time the course was offered, how will you modify the course to enhance learning? You can also address how the course could be improved, and what changes in the course content or pedagogy you plan to make, based upon on the findings. Please include a time frame for the changes.

VII. SYLLABUS AND SUBMISSION

Please submit syllabus in a separate file with the completed and signed form to the Faculty Senate Office, UH 221. The learning goals for the Natural Science Group must be included on the syllabus. An electronic copy of the original signed form is acceptable.