# LETTER OF INTENT to DEVELOP a NEW ACADEMIC PROGRAM

**General Information** **Date: 5-25-17**

| Campus: | Program: Title, CIP, Degree/Certificate Awarded |
|---|---|
| **University of Louisiana at Lafayette** | **Interdisciplinary Geosciences; CIP 40.0699, Ph.D. in Earth and Energy Sciences** |

Institutional Contact Person & Access Info (if clarification is needed):

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**1. Program Objectives and Content**

Describe the program concept: purpose and objectives; basic structure and components/concentrations; etc.

**PURPOSE AND OBJECTIVES**

We aim to offer a cutting-edge, interdisciplinary Geosciences doctoral degree program that integrates the expertise of the School of Geosciences (Departments of Geology and Environmental Science) with that of the Departments of Chemistry and Physics at UL Lafayette to provide new education and research opportunities to the next generation. Our students will develop an inter-disciplinary and multi-disciplinary understanding of issues central to meeting Energy and Environmental challenges of today and the future. The proposed focus on energy will reach well beyond the oil and gas industry — an emphasis of our current degree program in Geology — to include coursework and research training opportunities in biofuels, geothermal energy, solar-, wave-, and wind-energy. The proposed focus on the environment will include coursework and research training opportunities on the chemistry of soils and waters, the anthropogenic impacts of energy acquisition, ocean and land ecosystems, climate change, pollution, and research aimed to mitigate climate change such as carbon sequestration. These focus areas will be informed by a multidisciplinary foundation in physics, geophysics and the chemistry of Earth systems. Students will make fundamental contributions to these areas of research, and, furthermore, will learn how to apply their understanding of energy and the environment to solve real-world problems and to advance decision-making in business and regulatory arenas. Their efforts will result in more translational research, increased technology transfer, more research commercialization, and new and stronger business partnerships that will provide increased economic benefits to the state of Louisiana and to the nation. The establishment of the doctoral program at UL Lafayette in Earth and Energy Sciences will substantially enhance the existing undergraduate and master's-level degree programs in Chemistry, Physics, Geology, and Environmental Science on our campus by providing new research opportunities, spurring new collaborations, and giving students new opportunities for furthering their education. Finally, building an interdisciplinary doctoral program in Earth and Energy Sciences from four existing programs on our campus will enhance the recruitment and retention of top faculty in each of these disciplines and, as a result, improve the scientific infrastructure of the university and State of Louisiana.

**RESOURCES**

Below, 20 primary faculty members are listed whose research interests and expertise align with the proposed doctoral program in Earth and Energy Sciences. These faculty members are research active and have the necessary qualifications to direct Ph.D. dissertation research. Most of these faculty are active in multidisciplinary research. Drs. Zhang and Morra are faculty members who hold joint appointments in Geosciences and Physics.

- Dr. David Borrok, Professor, Geology
- Dr. Katie Costigan, Assistant Professor, Environmental Science
- Dr. August A. Gallo, Professor, Chemistry
- Dr. Raphael Gottardi, Assistant Professor, Geology
- Dr. Aubrey Hillman, Assistant Professor, Geology
- Dr. William A. Hollerman, Professor, Physics
- Dr. Thomas Junk, Professor, Chemistry
- Dr. Gary Kinsland, Professor, Geology
- Dr. Febee Louka, Associate Professor, Chemistry
- Dr. Gabrielle Morra, Assistant Professor, **Physics/ Geology (Interdisciplinary joint faculty hire)**
- Dr. Andi G. Petculescu, Assistant Professor, Physics

- Dr. Gabriela L. Petculescu, Associate Professor, Physics
- Dr. Durga Poudel, Professor, Environmental Science
- Dr. Carl Richter, Professor, Geology
- Dr. Brian Schubert, Assistant Professor, Geology
- Dr. Natalia Sidorovskaia, Professor, Physics
- Dr. Radhey Srivastava, Professor, Chemistry
- Dr. Jenneke Visser, Associate Professor, Environmental Science
- Dr. Xu Wu, Associate Professor, Chemistry
- Dr. Rui Zhang, Assistant Professor, **Geology/Physics (Interdisciplinary joint faculty hire)**

**GAs (number, funding source, full or tuition-waiver only):**
UL Lafayette will support seven new, continuing graduate teaching assistantships for this program, each of which includes a tuition/fee waiver and monthly stipend. Graduate assistantships are critically important to enable successful recruiting and retention of highly-qualified students. Graduate assistantships also help to offset faculty workloads, which are expected to increase with the inception of a doctoral program. In addition, Geology will transition one existing teaching assistantship at the M.S. degree level to the proposed doctoral program.

**Labs:**
We do not require any additional laboratory space for this program. We have in place high-quality research labs and instrumentation in the three buildings currently occupied by the School of Geosciences and the Departments of Physics and Chemistry.

**Other Physical Facility Needs:**
We do not require additional room for research space, classrooms, or faculty and staff offices at this time. We will, however, require additional office space for graduate research assistants and teaching assistants. It is important for teaching assistants to hold office hours in a consistent location where students from their courses can come for academic support. It is also important that graduate research assistants have space adjacent to the labs where they work so that faculty can appropriately supervise them.

**Other Resources Needed:**
None. The existing infrastructure for our undergraduate and M.S.-level programs can support the proposed doctoral program in Earth and Energy Sciences. We have the necessary space, faculty, and administrative support in place.

**Competitive/Similar Programs in Louisiana and in Neighboring States:**
According to the Louisiana Board of Regents degree inventory, Louisiana State University has individual Ph.D. programs in Geology, Environmental Science, Physics, and Chemistry. The University of New Orleans has a Ph.D. program in Chemistry and an interdisciplinary Ph.D. program in Engineering and Applied Science. The latter degree is an umbrella program for 9 disciplines, which include Physics and Earth and Environmental Science. Table 1 summarizes the Ph.D. programs at UNO and LSU that may have partial overlap with our proposed program.

**Table 1.**
**Ph.D. degree programs at LSU and UNO that are related to the proposed Ph.D. in Earth and Energy Sciences**

| Institution | Degree | Administered by | Concentrations or focus areas |
|---|---|---|---|
| Louisiana State University | Ph.D. in Environmental Science | Department of Environmental Science in the College of the Coast and Environment | Biophysical Systems; Environmental Planning and Management; Environmental Assessment and Analysis |
| Louisiana State University | Ph.D. in Geology | Department of Geology and Geophysics | Evolution of Sedimentary Systems and Earth Materials and Solid Earth Processes |
| Louisiana State University | Ph.D. in Physics and Astronomy | Department of Physics and Astronomy | Astronomy, astrophysics, gravitation and relativity, nuclear and particle physics, medical physics, materials physics, atomic/molecular/optical physics, and quantum optics and computing. |

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|---|---|---|---|
| Louisiana State University | Ph.D. in Chemistry | Department of Chemistry | New methods for synthesis of biomedically important compounds, nanomaterials, energy storage, computational models for assorted phenomena, ultra-fast lasers, and designer polymers. |
| University of New Orleans | Ph.D. in Chemistry | Department of Chemistry | Analytical Chemistry, Biochemistry, Inorganic, Medicinal, Materials, Organic, and Physical Chemistry. |
| University of New Orleans | Ph.D. in Engineering and Applied Science | Jointly run by Colleges of Science and Engineering | Civil and Environmental Engineering, Electrical Engineering, Mechanical Engineering, Naval Architecture/Marine Engineering, Engineering Management, Physics, Mathematics, Earth and Environmental Science, Computer Science. *The program provides the candidate with substantial depth in one branch of engineering or science as well as a broad base of interdisciplinary knowledge.* |

**Why our program is different:**

The proposed doctoral program in Earth and Energy Sciences will benefit students who desire an inter-disciplinary and multi-disciplinary doctoral degree in the Physical Sciences with particular applicability to Environmental research. The doctoral degree program incorporates coursework and research training opportunities pertinent to each of the partnering disciplines. **Thus, each student in this program will receive 12 hours of structured interdisciplinary coursework that integrates Chemistry, Environmental Science, Physics, and Geology. This approach of requiring a core set of interdisciplinary courses for every student in our program is distinct from traditional Ph.D. degree programs in a single discipline.** This approach will ensure that every student will receive adequate 'breadth of training' in the Earth and Energy Sciences. An additional 30 hours of coursework and dissertation research will ensure that the students receive adequate 'depth of training' in the Earth and Energy Sciences. Although it is possible for students to seek out interdisciplinary interactions within a traditional Ph.D. program at other universities by taking some courses in other disciplines or programs, it is not part of their required curriculum structure. This proposed approach is also distinct from umbrella programs that encourage interdisciplinary coursework but do not require a specific set of interdisciplinary courses for all of their students. By requiring a core inter-disciplinary or multi-disciplinary foundation, graduates will be better prepared to engage and solve problems across disciplines because they will have been prepared in Physics, Chemistry, Geology, and Environmental Science with an emphasis on problem solving. Accordingly, graduates will be ideally suited to pursue a wide range of career options in a variety of Physical Science and Environmental Science disciplines (e.g., academic careers in Chemistry, Geology, Physics, and Environmental Science programs, research scientists with organizations such as the EPA, DOE, and USGS, state government positions with organizations such as LDEQ and LDNR, and industry jobs in oil and gas, bio-fuel/tech, environmental management/consulting).

**On-line Delivery Possible/Probable/Feasible?**

Courses will initially be taught using the traditional delivery methods, but opportunities may arise in the future for online or hybrid delivery of some individual courses.

**Consortial Delivery Possible? With what institution(s)?**

The proposed doctoral program in Earth and Energy Sciences will be self-sufficient and supported by highly-qualified faculty with substantial expertise in energy (e.g., fossil fuels, biofuels, geothermal) and the environment. Many of the necessary courses are already available at UL Lafayette.

**Other Special Considerations:**

Through our current undergraduate programs in Physics, Geology, Environmental Science, and Chemistry, and Master's degree programs in Geology, Environmental Resource Science, and Physics, we have developed a network of industry, government, and academic collaborators and partnerships in Louisiana that will likewise be useful for the doctoral program in Earth and Energy Science.

**Adjunct Faculty:**
Adjuncts will help to support research, teaching, and in some cases can serve on graduate -student advisory committees.

- Dr. Thomas Doyle – US. Geologic Survey, National Wetlands Research Center
- Dr. Ken Krauss – US. Geologic Survey, National Wetlands Research Center

**Institutional Partnerships:**
The following organizations indicated their support for the creation of this program.

- Chevron
- Halliburton
- Schlumberger
- Stone Energy
- KourCo Environmental Services
- Fugro Geoservices
- ASV (Autonomous Surface Vehicles)
- The Louisiana Department of Environmental Quality
- The Louisiana Department of Agriculture and Forestry
- The National Resources Conservation Service
- Ion Energy
- The U.S. Geological Survey National Wetlands Center
- Eni US Operating Co.
- The Louisiana Immersive Technologies Enterprise (LITE)
- Fenstermaker
- US Geological Survey National Wetlands Research Center

**BASIC STRUCTURE AND COMPONENTS/CONCENTRATIONS**

**Admission and Degree Completion Requirements:**
UL Lafayette uses a portfolio approach to graduate admission that involves a thorough evaluation of student capabilities measured by several metrics inclusive of the GRE Exam (Graduate Record Exam), TOEFL (Test on English as a Foreign Language), written essays (e.g., both writing samples and personal statements), reference letters, and evaluation of transcripts from previous educational institutions. Of these, only academic record, TOEFL scores, and GRE results are directly measurable. Hence, for direct admission (B.S. to Ph.D.), the proposed program in Energy and Earth Sciences will require students to hold a B.S. in Geology, Environmental Science, Physics, or Chemistry (or a related field as determined by program faculty), with at least a 3.0 cumulative GPA in their B.S. program. Post-M.S. students who apply must also have their degrees in Geology, Environmental Science, Physics or Chemistry, and have a cumulative graduate GPA of at least 3.3. All incoming students must have completed (at a minimum) two classes and associated labs each in Geology, Physics, and Chemistry (i.e., a total of six lecture classes and six lab classes) and must have completed Calculus I and II. The preferred GRE score expectations for all applicants for the proposed doctoral program will be a verbal score of 145 and total verbal + quantitative score of 294.

Applicants who meet these criteria will be further reviewed by a graduate advisory committee for the Earth and Energy Science program comprising representatives from each of the participating disciplines. These representatives will be appointed by the appropriate Department Heads or School Directors. The graduate advisory committee is charged with admitting students into the doctoral program and for early advising of graduate students.

The graduate advisory committee will work with each newly admitted student to develop an individual development plan (IDP) and monitor the progress of these students in the first few years in the degree program. The IDP will assist students as they navigate early coursework and the selection of a major professor in the second to third year of study. At that point, the major professor and student will form the dissertation committee. The dissertation committee will then assume responsibility for supporting the student's IDP and for monitoring the progress of the student until they graduate.

Additionally, students must maintain at least a 3.0 cumulative GPA over the entire course of their program of study. No more than one course in which a grade of "C" is earned may be applied to the fulfillment of the degree requirements. Any student who is admitted to the program with a M.S. degree will be eligible to transfer up to 18

credit hours towards coursework in the doctoral program in Earth and Energy Science, subject to approval by the Graduate School and the graduate advisory committee.

**Total Number of SCHs Required and Estimated Time Required for Student Completion:**
A total of 72 credit hours will be required beyond the B.S. degree. Students with a M.S. degree can transfer up to 18 credit hours. The breakdown of course requirements is as follows:

| | | |
|---|---|---|
| **Core Courses** | 12 hrs | These are four interdisciplinary courses that will be taught by faculty specializing in Chemistry, Environmental Science, Geology, and Physics. |
| **Additional Coursework** | 30 hrs | These courses will consist of a combination of existing courses (relevant graduate-level courses in Biology, Chemistry, Engineering, Geology, Environmental Science, Mathematics, or Physics) and newly-developed courses (doctoral-level courses in Geology, Physics, Chemistry and Environmental Science). Students, in consultation with their dissertation committee, will develop a plan of courses in which to enroll based on their specific career goals and interests. As mentioned above, students who are admitted to the program with an M.S. degree in a closely-related field will be eligible to transfer up to 18 credit hours towards this 30 hour course requirement. To ensure that students have a strong multi-disciplinary background, they will be required to take at least 6 hours of coursework each in Geology, Chemistry, and Physics. The remaining 12 hours can be taken in any of the aforementioned disciplines. |
| **Graduate seminar** | 6 hrs | These hours will be accumulated from 6 semesters of taking a 1-credit hour graduate seminar course each semester. Seminars will include invited talks from internal and external speakers. External speakers will include a mix (approximately 50/50) of academic researchers and industry professionals so that students can gain insight into fundamental research and applied research topics. Each student will be required to deliver at least one presentation at the graduate seminar each year as he/she progresses in the doctoral program. |
| **Dissertation research and dissertation** | 24 hrs | A minimum of 24 credit hours in dissertation research and/or dissertation must be completed. Dissertation hours are intended for research and/or writing related to a student's dissertation topic(s) and performed in the last two years of the degree program after the student has been admitted to candidacy, a dissertation committee has been established, and the dissertation proposal has been approved by the dissertation committee. Dissertation hours will be supervised by the student's primary advisor/mentor and coordinated with his/her dissertation committee. |
| **Total** | **72 hrs** | |

**Additional Requirements:**

1) *General comprehensive exam:* The comprehensive exam will be administered at the end of a student's third semester of study. This exam will focus on the student's mastery of the content obtained from the courses taken within the program and application to structure research and solve problems. The comprehensive exam will be written and administered by a committee of three graduate faculty members of the Earth and Energy Sciences doctoral degree program of the student's choosing (preferably professors who have taught core courses). Graduate faculty representing at least two separate disciplines will be required to prepare the exam. Exams will be assessed by the faculty members who administered the exams, using rubrics to ensure consistency. A student must receive a 70% or higher on two of three subject matter tests and have an overall average score of 70% or better to pass the comprehensive exam. If a student fails more than one subject matter exam, he or she can re-take the failed exams with new questions within a period of time not to exceed three months. No student will be permitted a third attempt. If the student fails the second attempt, he/she will be dismissed from the program.

2) *Dissertation committee*: After successfully completing the comprehensive exam and prior to the proposal defense the student, in consultation from his/her major advisor, must choose a formal dissertation committee. The dissertation committee will consist of the primary advisor/mentor and at least three additional graduate faculty members. The committee must include at least two graduate faculty members from a discipline represented by the doctoral program but not that of the primary advisor. An external committee member from another institution is recommended.

3) *Dissertation proposal defense:* Prior to the initiation of the student's dissertation study, an oral defense of the dissertation proposal will be presented to the student's dissertation committee. This proposal defense will lay out the plan for the research topic, goals, methods, and expected results along with any preliminary data. During the dissertation proposal defense, a student is expected to demonstrate knowledge gained in his or her coursework and outside reading and its application to the proposed research plan. Students should demonstrate an understanding of the relationships among fundamental research and applied research applications in relation to their chosen research topic. An acceptance of the proposal by the major professor and a majority vote of the dissertation committee will be both required. The dissertation proposal defense is expected to be completed no later than the end of the third year of study, and after the student has passed the comprehensive exam.

4) *Dissertation:* The final examination will be a public, oral dissertation defense administered after the written dissertation is completed and reviewed by the student's dissertation committee. This oral exam will follow a traditional dissertation defense structure used with the majority of science Ph.D. programs. The dissertation is expected to represent an original contribution within Earth and Energy Sciences and to be of quality acceptable for publication in peer-reviewed journals in the appropriate field of study. Submission of at least one article to a peer-reviewed journal is a requirement for graduation.

**Core interdisciplinary courses:**

1. EES 600 Introduction to Earth Systems (3 credit hours). This course will provide students with a fundamental understanding of the surface, subsurface, and atmospheric systems on Earth and modern observational tools employed to study these systems.
2. EES 601 Fundamentals of Environmental Science (3 credit hours). This course will prepare students to understand environmental problems, data collection, and analysis from the multi-disciplinary perspective of the physical sciences.
3. EES 602 Energy Systems (3 credit hours). This course will provide an overview of energy production systems, emphasizing research and data analysis within the petroleum, bioenergy, and sustainable energy sectors.
4. EES 603 Research Challenges in Earth and Energy Sciences (3 credit hours). The course will introduce recent research progress and methodologies employed to address specific challenges and problem solving associated with energy exploration and environment sustainability.

**Elective Courses:**

**New courses; BIOL = Biology; CHEM = Chemistry; CIVE = Civil Engineering; EMGT = Engineering Management; ENVS = Environmental Sciences; GEOL = Geology; PETE = Petroleum Engineering; PHYS = Physics; MATH = Math.*

**Physical Science Disciplines**

1. CHEM 501 PHYSICAL CHEMISTRY. (3, 0, 3). Prereq: CHEM 232, 302.
2. CHEM 506 PHYSICAL CHEMISTRY OF SURFACES. (3, 0, 3). Interfacial characteristics including the determination of surface properties and thermodynamic relationships; adsorption at, electrical aspects of, and reactions at surfaces. Applied topics emphasize nucleation, friction and lubrication, detergents and flotation, and emulsions and foams. Prereq: CHEM 302.
3. *CHEM/EES: 605 BIOENERGY APPLICATIONS (3, 0, 3). Permission from instructor required.
4. ENVS 580: FATE OF POLLUTANTS IN SOILS AND NATURAL WATERS. (3, 0, 3). (no course description)
5. *ENVS 585/EES: RENEWABLE ENERGY SOURCES. (3, 0, 3). Scientific and economic understanding of renewable energy resources, including biofuels, solar, wind, hydrogen, etc. No prerequisites are required.
6. GEOL 502. ADVANCED SEDIMENTATION. (3, 0, 3). Sedimentary environmental and facies, with special emphasis on fluvial, deltaic, shoreline, deepwater, and eolian clastic facies. Prereq: GEOL 339.
7. GEOL 504. EXPLORATION GEOPHYSICS. (2, 3, 3). Introduction to the techniques of exploration geophysics. Prereq: MATH 270, PHYS 208-218 or permission of the instructor required.
8. GEOL 505. GEOTECTONICS. (3, 0, 3). Tectonic theories, with special emphasis on plate tectonics. Restr: Permission of instructor is required.
9. GEOL 506. SEISMIC STRATIGRAPHY. (3, 0, 3). Appearance of stratigraphic features on modern exploration seismic sections. Theory and real life examples integrated. Restr: Permission of instructor required.
10. GEOL 509. ADVANCED GROUND WATER HYDROLOGY. (3, 0, 3). Discussion of case histories and examples that apply the basic principles of ground water hydrology to specific sites and problems. A summary of current thoughts, ideas, and practical applications related to hydrology. Prereq: GEOL 470(G) or permission of

instructor required.

11. GEOL 510. ADVANCED ENVIRONMENTAL GEOLOGY. (2, 3, 3). Content varies. May be repeated for credit. Application of geology to problems resulting from the increasingly intense use of the earth and its resources. Restr: Permission of instructor required.
12. GEOL 531. ADVANCED CARBONATE SEDIMENTOLOGY. (1-4). Carbonate facies belts, some emphasis on hydrocarbon exploration. Field examples studied; up to three field trips to selected carbonate outcrop areas. Prereq: GEOL 442(G).
13. GEOL 532. PETROLEUM GEOCHEMISTRY. (2, 3, 3). Concepts and principles of geochemistry. Course includes examination of natural samples. Prereq: GEOL 292, CHEM 108 or permission of instructor required.
14. GEOL 535. ADVANCED TOPICS IN GEOLOGIC COMPUTING. (2, 3, 3). Image analysis, digital mapping methods, digital modeling of geologic systems, and export systems. Prereq: GEOL 435(G) and an introductory programming class.
15. GEOL 540. ADVANCED STRUCTURAL GEOLOGY I. (3, 3, 4). Applied interpretation concepts of contractional and strike-slip terrains. Includes field work, geophysical, and remote sensing approaches. Prereq: an introductory structural geology course. A field camp course is highly-recommended.
16. *GEOL/EES 605. STABLE ISOTOPE GEOCHEMISTRY (3, 0, 3). This course will explore the principles of stable isotope fractionation, including the O, C, and H isotope systems, but will also explore non-traditional stable isotope systems such as Ca, Mg, Si, Fe, Zn, etc. Prereq: GEOL 532, 602, or permission of instructor required.
17. *GEOL/EES 610. UNCONVENTIONAL RESOURCES. (3, 0, 3). This course will focus on shale gas/oil exploration and development. Prereq: GEOL 540 or an introductory structural geology course and permission of the instructor.
18. *GEOL/EES 620. ADVANCED GEOPHYSICAL TECHNIQUES (3, 0, 3). Signal processing, interpretation, and hands-on field-based instruction for understanding seismic and other geophysical data. Prereq: GEOL 504 and/or EEEP 602.
19. PHYS 521. TOPICS IN APPLIED PHYSICS: Applied Ion Beam Methods (1,2,3) (3, 0, 3). A use of high energy particle beams at the Louisiana Accelerator Center for material analysis with emphasis on geophysical and geochemical applications.
20. *PHYS/EES 601. PHYSICAL PROPERTIES OF MINERALS (2, 1, 3) Understanding the physical properties of minerals such as metallic elements, their alloys and compounds, rocks, and non-metallic solids. Properties such as elasticity, magnetism (iron is the most abundant element in Earth's composition), thermal conductivity, specific heat, thermal expansion, piezoelectricity, and piezomagnetism, are to be discussed. The course will introduce the students to concepts of solid-state physics needed for setting up a base for understanding the physical processes that affect the defined properties. Experimental methods used to determine the discussed physical properties will be described.
21. *PHYS 602/EES. CLIMATE PHYSICS (3, 0, 3). The course is intended as a starting point for students wishing to understand the physics of Earth's atmosphere. The main topics addressed are atmospheric dynamics, atmospheric (photo-)chemistry, and climatology. During the course the students will learn how to use fluid mechanics, statistical physics, chemical models, radiation balancing, and energy transfer processes to characterize the atmosphere. Time-permitting, a number of various interesting phenomena such as lightning and thunder, internal gravity waves, and the acoustic heating of the thermosphere will be addressed as applications.

**Supporting Disciplines**

1. BIOL 502. QUANTITATIVE ECOLOGY. (3, 0, 3). Quantitative methods for analysis in Ecological studies including ecological models, model selection, maximum likelihood estimation, and mark-recapture analysis.
2. BIOL 503. ECOLOGICAL MODELS AND DATA. (3, 0, 3). (no course description)
3. BIOL 575 STATISTICAL ECOLOGY. (4, 0, 4). Design, analysis, and presentation of results of ecological experiments and field studies, with emphasis on hypothesis testing and statistical modeling. Prereq: STAT 417(G) or permission of instructor required.
4. BIOL 580. MARINE ECOLOGY. (3, 0, 3). Discussions of basic principles of marine ecology, including productivity, dynamics of populations, factors affecting distribution, and interactions between organisms.
5. BIOL 605. ADVANCED TOPICS IN ENVIRONMENTAL BIOLOGY. (3, 0, 3). (no course description)
6. BIOL 615. BIOCHEMICAL ADAPTATION TO THE ENVIRONMENT. (3, 0, 3). Modification of basic biochemical structure and function that enable organisms to exist in extreme environments; enzymatic and metabolic adaptation to hypoxia, salinity, temperature, pressure, humidity and light.
7. CIVE 506: ADVANCED HYDROLOGY. (3, 0, 3). Quantitative approaches for modeling rainfall-runoff processes. Topics include lumped and distributed models, treatment of spatial and temporal hydrologic variability,

hydrologic data quality control, and design of hydrologic networks. Restr: Permission of instructor required.

8. CIVE 546: PROBABILISTIC METHODS IN HYDROSCIENCE. (3, 0, 3). General review of advanced probability and statistics concepts, Monte Carlo simulation of hydro-systems, probabilistic models of observed hydrologic data, optimal estimation and interpolation of geophysical fields. Use of data-intensive computer applications is emphasized. Restr: Permission of instructor required.
9. CIVE 561: WATER TREATMENT. (3, 0, 3). Design of domestic and industrial water treatment facilities with emphasis on the basic scientific principles underlying the design procedures. Prereq: CIVE 321 or permission of instructor required.
10. CIVE 563: SOLID AND HAZARDOUS WASTE MANAGEMENT. (3, 0, 3). Current issues and legislation. Collection, storage and disposal. Treatment technologies including incineration and sanitary and hazardous waste landfills. Prereq: CIVE 321 or permission of instructor required.
11. CIVE 567: EXPERIMENTAL ANALYSIS FOR ENVIRONMENTAL ENGINEERS. (0, 6, 3). Examination of laboratory techniques for assessing water quality and sludge contamination. Optical, electrical, gas chromatography, and x-ray methods are included. Prereq: Students must have taken CIVE 321 or equivalent course or permission of instructor required.
12. CIVE 646: PROBABILISTIC METHODS IN HYDROSCIENCE. (3, 0, 3). Advanced probability and statistics concepts, Monte Carlo simulation of hydro-systems, probabilistic models of observed hydrologic data, optimal estimation and interpolation of geophysical fields. Use of data-intensive computer applications is emphasized. Permission of instructor required.
13. EMGT 502: PROJECT ECONOMICS. (3, 0, 3). Procedures for conducting economic analyses used by technical managers. Fundamental methods followed by more advanced topics such as capital budgeting, leveraged investments, decision under risk and uncertainty, and use of modern software systems.
14. EMGT 550: ENGINEERING AND TECHNOLOGY MANAGEMENT. (3, 0, 3). Management principles and practices applicable to technical organizations.
15. PETE 501 FORMATION DAMAGE CONTROL (3, 0, 3). Fundamentals of formation damage mechanisms, damage characterization and control, basic clay minerals engineering, control of screen entrance velocity, well treatment design, and well flow back analysis. Prereq: PETE 486, 489(G). Restr: If prerequisites not met permission of instructor required.
16. PETE 502 HORIZONTAL WELL ENGINEERING. (3, 0, 3). Environmental remediation with horizontal wells, reservoir or acquirer fluid flow to horizontal wells, modern downhole assemblies and production/injection/completion of horizontal wells. Prereq: PETE 489(G), 491, 494(G), 496. Restr: If prerequisites not met permission of instructor required.
17. PETE 578 ADVANCED PRINCIPLES OF NATURAL GAS. (3, 0, 3). Covers the theory and practice involving natural gas from its initial location in the reservoir to its final destination, including the design of an optimum development plan for a natural gas field. Unconventional gas sources also covered. Prereq: PETE 478, 494(G).
18. PETE 586. SECONDARY RECOVERY PROCESSES. (3, 0, 3). Theory of multiphase flow, miscible and immiscible displacement mechanisms in porous media. Analysis of various improved recovery methods such as water flooding, gas flooding on digital computer. Prereq: PETE 482(G).
19. PETE 587. NATURAL WATER DRIVE SYSTEMS. (3, 0, 3). Theory of natural aquifer expansion and water encroachment in porous media using classical influence functions for finite and infinite aquifer of linear and radial extent. Numerical simulation of water encroachment in arbitrary shaped patterns with irregular well distributions. Prereq: PETE 494(G), 478.
20. PETE 590. DRILLING OPTIMIZATION TECHNIQUES. (3, 0, 3). Methods and techniques to optimize drilling hydraulics, bit weight and rotary speed, penetration rates, and minimize drilling costs. Prereq: PETE 491.
21. PETE 591. TRANSIENT PRESSURE BEHAVIOR. (3, 0, 3). Mathematical development and analysis of transient behavior in well and reservoir systems. Factors influencing skin effect evaluation in heterogeneous porous media. Effect of horizontal and vertical factors, anisotrophy and shale barriers on reservoir limits tests. Prereq: PETE 494(G), 478.
22. PETE 592. ADVANCED PETROLEUM PRODUCTION SYSTEM AND OPTIMIZATION. (3, 0, 3). Principles of the development and operation of petroleum production system. Considers the combined behavior of the reservoir, the producing strings, the surface equipment, and pipeline system. Optimization of such a production system for various schedules. Prereq: PETE 486, 494(G).
23. PETE 593. ADVANCED GEOLOGIC WELL LOG ANALYSIS. (3, 0, 3). Study of advanced well logging methods and techniques for qualitative and quantitative use of well logs as geological mapping tools in hydrocarbon and mineral exploration. Prereq: PETE 481(G) or GEOL 410(G).
24. PETE 595. THEORY AND TECHNIQUES OF MATHEMATICAL RESERVOIR SIMULATION. (3, 0, 3). Comprehensive

coverage of the mathematical reservoir simulator with special emphasis on the practical application of theoretical techniques on modern-day computers. Prereq: PETE 494(G) and MATH 350 or 455(G) and a working knowledge of FORTRAN or permission of the instructor.

25. MATH 495G. ADVANCED MATHEMATICS FOR ENGINEERS AND SCIENTISTS. (3, 0, 3). Systems of first order differential equations, partial differential equations, Fourier series, Sturm-Liouville systems, Hemholtz equation, Green's functions, applications in engineering and sciences. Prereq: MATH 350 with a grade of "C" or better.

**2. Need**

Outline how this program is deemed essential for the wellbeing of the state, region, or academy (e.g., accreditation, contribution to economic development; related to current or evolving needs within state or region). Cite data to support need: employment projections; supply/ demand data appropriate to the discipline and degree level, etc.

**WELL-BEING OF THE STATE**

The proposed doctoral program in Earth and Energy Sciences acts on recommendations put forth in the FIRST Louisiana report and the BOR 2011 Master Plan, targeting the need for a skilled interdisciplinary workforce that can address current and future challenges associated with the Earth Sciences and Energy. More recent recommendations to the Louisiana Board of Regents presented by the Master Plan Research Advisory Committee in 2014 highlight the need for the development of new academic programs in interdisciplinary sciences such as the one we present here. Several of the specific advantages for Louisiana are presented below:

- This doctoral program will increase the production of advanced STEM degrees in the state by providing more upper-level educational and research opportunities in areas of high growth, where more intellectual capacity is needed. There is no doubt that the citizens of Louisiana and the rest of the world will, in the near future, need improved acquisition and utilization of energy while, at the same time, need to minimize detrimental effects of acquiring and utilizing energy on the environment. While these goals are admirable, they will not be easily attained. The problems are complex and, accordingly, will need careful study by highly qualified scientists. We propose to prepare the next generation of scientists to address these goals by using a multidisciplinary approach that emphasizes the development of problem solving skills. We expect that graduates of this program will assume prominent, leadership positions in industry and government and, accordingly, will be in position to directly impact these goals. Graduates will learn to foster more technology transfer, research commercialization, and new and stronger business partnerships, thereby providing a healthy return on investment for the State of Louisiana. The proposed doctoral program will provide educational and research activities at the doctoral level that are fundamental in the sense that they will involve education and research opportunities inherent to the core disciplines, but also will include applied research that involves more than one discipline. The program will emphasize a problem-solving approach to preparing students. For example, our capstone core course, EES 603 *Research Challenges in Earth and Energy Sciences,* will emphasize problem-solving and application-based research. In addition, students will be exposed to applied research through our graduate seminars, which will include a mix of industry professionals in addition to academic researchers. Understanding and articulating the relationships among fundamental research and applied research applications associated with their dissertation topics will be an expectation for passing the dissertation proposal defense.

- The proposed doctoral program will serve as a catalyst for greater collaborations among four existing degree programs at UL Lafayette. These new collaborations will be manifested in the doctoral degree program in Earth and Energy Sciences. The development of this doctoral degree program, its successful implementation as evidenced by student recruitment, extramural funding of academic research, and graduation of students, will elevate the academic profile of these departments and, therefore lead will lead to an enhanced ability to recruit and retain top faculty in the State of Louisiana. The scientific infrastructure of UL Lafayette and the State of Louisiana will improve with the development and implementation of the proposed doctoral program in Earth and Energy Sciences. At UL Lafayette, we are strongly committed to interdisciplinary research and education and to preparing a strong faculty foundation for successful implementation of interdisciplinary programs. In particular, two of our recent hires in the College of Sciences are interdisciplinary faculty who hold joint appointments. Dr. Gabrielle Morra holds a 2/3 appointment in the Department of Physics and a 1/3 appointment in the School of Geosciences. Dr. Rui Zhang holds a 2/3 appointment in the School of Geosciences and a 1/3 appointment in the Department of Physics. These joint appointments align perfectly with the proposed, interdisciplinary doctoral degree program in Earth and Energy Sciences. The successful implementation of the proposed doctoral program in Earth and Energy Sciences will bring positive national and international recognition to the university and the State of Louisiana.

The proposed doctoral program in Earth and Energy Sciences specifically addresses the following goals and objectives in the **BOR 2011 Master Plan**:

**Goal 1, Objective 1.7: "*Develop a Skilled Workforce to Support an Expanding Economy*."**
The proposed doctoral program will prepare a new generation of scientists to support technical management and problem-solving in areas critical to the State of Louisiana in the energy sector as well as in environmental areas. Contributing to the development of a qualified labor pool in the domain of Earth Sciences will facilitate the attraction of new businesses to the area.

**Goal 2, Objective 2.1: "*Maintain and Build Strength in Foundational Science and Technology Disciplines Identified in FIRST Louisiana."***
Both Earth Sciences and Physical Sciences are targeted by FIRST Louisiana and these are precisely the areas we combine for the proposed doctoral degree program in Earth and Energy Sciences.

***"Recruit, cultivate, and retain research talent in the foundational sciences."***
The addition of a doctoral program in Earth and Energy Sciences will allow UL Lafayette to greatly expand research and research training in Chemistry, Earth Sciences, and Physics. The establishment of a new doctoral degree program in Earth and Energy Sciences will create the necessary academic infrastructure to attract quality research-active faculty and, furthermore, provide an incentive for them to develop successful research careers at UL Lafayette. In particular, the addition of this doctoral program will allow graduate faculty in four degree programs (Geology, Environmental Science, Physics, and Chemistry) new access to doctoral students. Such access to doctoral students will significantly enhance the scope, quality, and productivity of faculty research.

***"Develop and maintain cutting-edge infrastructure and facilities for fundamental science and technology research."***
We plan to leverage the doctoral program to secure new instrumentation through federal grants and plan to rely on doctoral students to help operate and maintain equipment.

**Goal 2, Objective 2.2: *"Promote Multidisciplinary and Multi-Institutional Collaborative Research Efforts."***
The proposed doctoral program in Earth and Energy Sciences integrates Chemistry, Environmental Science, Geology, and Physics. The program is multidisciplinary by design.

***"Address multi-disciplinary and multi-institutional collaborations in campus research plans."***
The proposed doctoral program in Earth and Energy Sciences employs a multidisciplinary approach to train scientists. Accordingly, the proposed doctoral program is consistent with the University of Louisiana at Lafayette's strategic plan for advancing interdisciplinary and multidisciplinary research and research collaboration.

**Goal 2, Objective 2.3: *"Sustain and Advance Research Commercialization and Translational Activities that Promote Economic Development in Louisiana."***
We are embracing translational research as a focus area in our program with the aim of bridging the gap between fundamental research and applied research. In particular, doctoral students will be trained to solve problems associated with the acquisition and utilization of energy in ways that minimize deleterious effects on the environment.

***"Promote Multidisciplinary and Multi-Institutional Collaborative Research Efforts."***
As described in Goal 2, Objective 2.2 (above), the proposed doctoral program in Earth and Energy Sciences will require doctoral students to complete coursework and research training derived from multiple disciplines. Such preparation will foster joint research efforts. Many of our faculty members already are collaborating across these disciplines, both within and outside of the university. The addition of the interdisciplinary doctoral program in Geosciences will further expand multi-institutional research opportunities as we anticipate involving high-caliber research faculty from other institutions as 'outside faculty members' serving on the dissertation committees of our doctoral students. Their involvement in student dissertation research projects will foster collaboration of between our research faculty and these 'outside faculty members'.

***"Foster networking and strategic collaborations between higher education, government, and Louisiana's existing and prospective high-growth industry sectors."***

Louisiana's high-growth industry sectors include *Energy Production* and *Coastal Resilience*. Our concentration areas include Energy and the Environment (which includes coastal environmental systems). Hence, the framework and educational approach of the proposed doctoral program in Earth and Energy Sciences will embrace translational research that will readily foster productive collaborations between higher education, industrial and government partners. We have in place established partnerships with more than a dozen companies and businesses that offer internships for our students at the undergraduate and M.S.-degree levels. These relationships will be strengthened and expanded with the implementation of the proposed doctoral program in Earth and Energy Sciences.

***"Build capacity in areas of competitive advantage and target niches which align with campus and State research priorities."***

As described above, the target niches of student are closely aligned both with the research priorities of UL Lafayette and the State of Louisiana. By filling these niches we add new educational opportunities and value to our students, our community, and society.

**EMPLOYMENT PROJECTIONS**

**State Demand**

The data in Table 2 suggest that 161 new positions that overlap with skillsets of our Earth and Energy Sciences Ph.D. graduates will be available annually from 2012 to 2022. Some of this growth will be satisfied by a workforce with Bachelor's and Master's Degrees and the extent to which Ph.D.-level candidates will be preferred is not known. The doctoral-level graduates will be suitable for leadership and management positions. Hence, the strong overall need for scientists in these physical science fields is a good indication of the need for growth at all levels. For example, the need for academic (post-secondary) positions in these areas, where a Ph.D. is frequently required, is expected to increase to 5 positions annually (until 2022) in Louisiana alone. Moreover, some of the demand for in-state Ph.D.s of this type is not captured in the current demand projections for Louisiana because state job projections do not account for state/federal agencies and private research groups that may have headquarters located outside of Louisiana. Nor do these projections include consultants and self-employed professionals, an exponentially growing employment segment in geosciences. Finally, there may be considerable growth in the energy sector outside of the oil and gas industry. Start-up companies in these areas of biofuel technology and development as well as conventional energy companies that aim to expand their operations will need scientists.

**Table 2.**
**Physical Sciences occupational projections for Louisiana**
**(Source: Louisiana Workforce Commission – Long-term Occupational Projections)**

| SOC Code | Occupational Projections for Louisiana | Projected annual openings 2012-2022 |
|---|---|---|
| 19-2042 | Geoscientists | 40 |
| 19-2012 | Physicists | 1 |
| 19-2041 | Environmental Scientists and Specialists | 80 |
| 11-9121 | Natural Science Managers | 10 |
| 19-2031 | Chemists | 30 |
| TOTAL | | 161 |

**National Demand**

Table 3 shows that there will be almost 2000 academic positions that require a Ph.D. that will open annually in the United States in areas represented in the Earth and Energy Sciences program. Considering the strong national focus on inter- and multi-disciplinary research associated with Energy (fossil fuel, biofuels, and other renewables) and the Environment (pollution, water resources), our graduates will be in a strong position to fill academic growth in these sectors. We also expect substantial growth at the national level for Ph.D. demand at research Institutes and within federal government agencies (e.g., USGS, EPA, DOE, etc.).

**Table 3.**
**Academic job estimates nationally (Source: US Bureau of Labor Statistics)**

| Occupational Code | Occupational Title | Projected average annual openings 2012-2022 |
|---|---|---|
| 25-1051 | Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary | 350 |
| 25-1053 | Environmental Science Teachers, Postsecondary | 180 |
| 25-1054 | Physics Teachers, Postsecondary | 580 |
| 25-1052 | Chemistry, Postsecondary | 880 |
| TOTAL | | 1990 |

As an example, the supply of newly-trained geoscientists falls remarkably short of future geoscience workforce demand and replacement needs. Forty-three percent of the current geoscience workforce is at or near retirement age. AGI's 2014 Workforce Report illustrates that the majority of current researchers at federal agencies are at or rapidly approaching retirement age. The Bureau of Labor Statistics indicates that all Geoscience jobs will increase by 10% from 2014 to 2024. In addition, a 2011 article in the journal *Nature* (Perkins, 2011; Nature 473, 243-244 doi:10.1038/nj7346-243a) explains that one of the geoscience employment sectors poised for the most growth is consultancy. This anticipated job growth will provide opportunities for geoscientists equipped with a strong set of fundamental skills, particularly postdocs with several years' of experience who elect to leave academia, and mid-career researchers who choose to leave government positions. The article goes on to state that "*many of today's senior geoscientists were trained as specialists in relatively narrow disciplines, but in the future, most demand will be for researchers who have been trained to appreciate the interdisciplinary nature of the Earth sciences*." In the petroleum sector, entry level geoscientists with B.S. and M.S. degrees have average starting salaries of $92,000 and $104,400, respectively, while entry-level geoscientists with a Ph.D. average $117,300 for a starting salary. These data demonstrate the value in obtaining an interdisciplinary Ph.D. in geoscience in order to compete for industry positions in addition to the more traditional academic career route.

In accordance with the Bureau of Labor Statistics, employment of physicists is projected to grow seven percent from 2014 to 2024, about as fast as the average for all occupations. According to several surveys conducted by the National Science Foundation over the last four decades, the private sector is the largest single employment base of Physics Ph.Ds. Having an interdisciplinary doctorate degree will make our graduates more competitive for private sector jobs, particularly in Louisiana. The median starting salary for these jobs is $90,000 for Physics Ph.D. recipients, which is considerably higher than $ 51,000 for B.S. degree and $ 60,000 for M.S. degree recipients in the same sector. This is indicative of a greater economic value of the Ph.D. degree for future careers. "*Physics Ph.D.s in potentially permanent positions experienced the greatest diversity concerning the field in which they are working. Forty-four percent of the Ph.D.s who accepted potentially permanent positions are working outside the field of physics, with the field of engineering comprising the largest portion of this group*" (Source: www.aip.org/statistics). Physics graduates have one of the lowest unemployment rates. In 2015, the Fortune magazine ranked Ph.D. degree in Physics as the 5$^{th}$ best graduate degree for the job market.

The demand for chemists, notably those with advanced degrees, is expected to increase at a 3% rate until 2024 (Source: U.S. Bureau of Labor Statistics). In practice, the demand for recent Chemistry graduates will be significantly higher, due to an over-aged workforce: in 1990, 43.5% of all chemists were under the age of 40, compared to only 25.8% in 2015. During the same time frame, the fraction of chemists within the labor force who hold a Ph.D. has increased from the 56.3% to 69.6%, indicating a steady shift towards more highly trained chemists (Source: ChemCensus 2015, American Chemical Society). In 2015, the median salary for Ph.D. chemists was $105,000, as compared to $77,000 for B.S. chemists and $87,000 for M.S. chemists, reflecting the economic value of a Ph.D. (Source: American Chemical Society). Currently, chemists fill 23,000 direct jobs in Louisiana and generate $2.2B in payroll, making our state one of the leading regions to offer employment opportunities for chemists (Source: American Chemistry Council).

Finally, because our doctoral graduates will have extensive, interdisciplinary coursework and research experience in Geosciences, Physics, and Chemistry, they will be more competitive for a larger number of job opportunities than doctoral graduates from more-conventional degree programs that offer training in only a single discipline (e.g., Geosciences, or Physics, or Chemistry). Furthermore, because our interdisciplinary program in Earth and Energy Sciences emphasizes translational research, our doctoral graduates will be competitive for industrial, governmental agency and academic job opportunities.

**3. Relevance**

Explain why this program is an institutional priority at this time. How will it (a) further the mission of the institution and (b) increase the educational attainment of the state's adult population or foster innovation through research.

The University of Louisiana at Lafayette is the largest member of the University of Louisiana System and is designated within the Carnegie classification as a Doctoral Research University with Higher Research Activity. In addition to the pursuit of excellence in education and research at all levels, the mission of the University is to promote regional economic and cultural development, to explore solutions to national and world issues, and to advance its reputation among its peers. The proposed doctoral program in Earth and Energy Sciences would advance UL Lafayette's existing role as a research university and support UL Lafayette's mission by producing graduates who will strengthen the local and regional economy, but will also bring honor and prestige to Louisiana as they find employment in other regions of the U.S. and internationally.

The proposed Ph.D. program in Earth and Energy Sciences is an institutional priority for UL Lafayette because it will integrate and strengthen four separate science degree programs, provide new opportunities for our students and faculty, increase the number of students receiving STEM degrees, and support the strategic directions for research at the University. Among other key disciplines, UL Lafayette aims to become a leader in research and education focused on Energy and the Environment. We are also positioning ourselves as an institution to become a leader in translational research in this area, bridging the gap between fundamental research and application-based research. Hence, the focus of this doctoral program fits perfectly within the strategic research and educational interests of our university.

**4. Students**

Summarize student interest/demand for the proposed program.

We plan to recruit students on our own campus who receive B.S. or M.S. degrees in Chemistry, Environmental Resource Science, Geology, and Physics (more than 115 students annually). We will also strongly recruit B.S. and M.S. students from other universities in our state, as well as nationally and internationally. By combining four separate programs into an interdisciplinary Ph.D. program, we will be greatly expanding the base of students from which we can recruit. One of our initial recruiting strategies will be to send out recruiting information to the relevant programs including HBCUs that offer B.S. and M.S. degrees in the Gulf Coast region. We will additionally use resources such as the GRE exam search service, the McNair Scholars Directory, and online directories to identify potential candidates who have demonstrated graduate-level readiness for our program and we will reach out to all of them via e-mail. Such efforts have been a successful recruiting approach for our other graduate programs. In addition to these efforts, we plan to build social media and SEO-based recruitment initiatives.

To assess demand for an interdisciplinary Geosciences Ph.D. program among our current students, we conducted a survey of undergraduates and graduate students majoring in Geology, Physics and Environmental Sciences at UL Lafayette. Of the 169 student respondents, 38% expressed intent to continue their graduate education on a full-time basis. When asked "if UL Lafayette offered a Ph.D. program in your field of study that would prepare you for success in either the academic environment or in industry, would you be interested in enrolling," 47% responded "yes." Corroborating this strong expression of interest, 39% of the respondents indicated (on a 1 to 10) scale that they would likely pursue a Ph.D. in Geosciences at UL Lafayette, while 17 students indicated they would definitely enroll in such a program (by indicating a 9 or 10, where 10 represented "complete certainty"). We also inquired about geographic preferences for school location in pursuing a Ph.D. in Geosciences. Fifty-six percent expressed a definite interest in staying in the State of Louisiana, and 32% (or 54 students) indicated an absolute preference for continuing on to their doctoral education at UL Lafayette. Interestingly, 33% of the sample indicated that they would pursue a Ph.D. in Geosciences but *only if* it was offered at UL Lafayette. The primary two motivators for students seeking a Ph.D. in Geosciences were: (1) the chance to learn more about their profession, (2) the opportunity to earn

a higher salary. Results also suggest that about 55% of respondents would intend on working in academics and 45% in industry upon completion of a Ph.D. in Geosciences. Ten students indicated they had already decided to pursue a Ph.D. immediately following graduation as a definite career plan. A separate survey was recently administered to students in Chemistry. Of the 32 respondents, 27 (79%) were considering graduate studies either at the M.S. or Ph.D. level.

**Projected Student Enrollment:**

**Table 4.**
**Projected enrollments and student funding mechanisms for years 1-5.**

| Year | Total Enrolled | Funding | | | |
|---|---|---|---|---|---|
| | | Industry-Funded | Self-Funded | Research-Funded | University-Funded Graduate Assistantships[1] |
| 1 | 5 | 0 | 0 | 1 | 4 |
| 2 | 10 | 1 | 0 | 2 | 7 |
| 3 | 15 | 3 | 1 | 3 | 8 |
| 4 | 18 | 3 | 2 | 5 | 8 |
| 5 | 20 | 4 | 2 | 6 | 8 |

[1]This includes 4 new, continuing assistantships in year 1 and 3 new, continuing assistantships in year 2 (for a total of 7). One additional assistantship originally allocated to the Geology M.S. degree program will be shifted for use in the Ph.D. program.

The enrollment projections in Table 1 appear to be in line with other Ph.D. programs in the Physical Sciences. For example, LSU's Ph.D. program in Geology had enrollments of 16, 17, 20, 26, and 29 in the Fall semesters of the 2010-2011, 2011-2012, 2012-2013, 2013-2014, and 2014-2015 academic years, respectively. We plan to continue to grow enrollment after the program has been established in the first five years.

**5. Cost**

Estimate costs for the projected program for the first five years. Indicate amounts to be adsorbed out of current sources of revenue and needs for additional appropriations (if any). Commit to provide adequate funding to initiate and sustain the program.

Our proposed program can be fully implemented with limited cost to UL Lafayette. This includes no new funds required for faculty, supplies, operating expenses, or travel. Costs incurred by seven new and continuing graduate assistantships represent a necessary investment in the success of the program. In addition to the seven graduate assistantships requested from UL Lafayette, students will be funded by external research funds and by industry partners, either through the creation of company-sponsored assistantship or corporate funding as a business recruiting tool for graduates. Finally, Ph.D. students will have full access both to the UL Lafayette and the LSU libraries, as well as resources provided through the LOUIS consortium, so little or no additional library costs are anticipated.

**CERTIFICATION**:

_____ _____
Chief Academic Officer Date

_____ _____
Chancellor/President Date

_____ _____
Management Board Date

## SUMMARY OF ESTIMATED ADDITIONAL COSTS/INCOME FOR PROPOSED PROGRAM

**nstitution: University of Louisiana at Lafayette** **Date: May 25, 2017**

**Degree Program, Unit: Ph.D. in Earth and Energy Sciences**

FTE = Full Time Equivalent (use the institution's standard definition and provide that definition).

| EXPENDITURES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **INDICATE ACADEMIC YEAR:** | **FIRST** | | **SECOND** | | **THIRD** | | **FOURTH** | |
| | **AMOUNT** | **FTE** | **Amount** | **FTE** | **AMOUNT** | **FTE** | **AMOUNT** | **FTE** |
| Faculty | $ | | $ | | $ | | $ | |
| Graduate Assistants (university funded) | $76,000 | | $136,500 | | $140,000 | | $143,500 | |
| Support Personnel | | | | | | | | |
| Fellowships and Scholarships | | | | | | | | |
| **SUB-TOTAL** | $76,000 | | $136,500 | | $140,000 | | $143,500 | |
| | | | | | | | | |
| | **AMOUNT** | | **AMOUNT** | | **AMOUNT** | | **AMOUNT** | |
| Facilities | $ | | $ | | $ | | $ | |
| Equipment | $3,760 | | $2,820 | | | | | |
| Travel | | | | | | | | |
| Supplies | 400 | | 700 | | 700 | | 700 | |
| Other (specify) | | | | | | | | |
| **SUB-TOTAL** | $ 4,160 | | $3,520 | | $ 700 | | $ 700 | |
| **TOTAL EXPENSES** | $ 80,160 | | $140,520 | | $140,700 | | $144,200 | |
| **REVENUES** | | | | | | | | |
| Revenue Anticipated From: | **AMOUNT** | | **AMOUNT** | | **AMOUNT** | | **AMOUNT** | |
| *State Appropriations | $71,658 | | $143,317 | | $167,203 | | $210,198 | |
| *Federal Grants/Contracts | | | | | | | | |
| *State Grants/Contracts | | | | | | | | |
| *Private Grants/Contracts | | | | | | | | |
| Expected Enrollment | 5 | | 10 | | 15 | | 18 | |
| Tuition | $27,553 | | $55,106 | | $64,290 | | $80,822 | |
| Fees (undedicated) | 2,203 | | 4,406 | | 5,140 | | 6,462 | |
| *Other (specify) | | | | | | | | |
| **TOTAL REVENUES** | $101,414 | | $202,829 | | $236,633 | | $297,482 | |

* Describe/explain expected sources of funds in proposal text.