

# *Environment 2020*



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## A Proposal Prepared by the Environmental Initiative Task Force

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## **INTRODUCTION: WHY ENVIRONMENT 2020?**

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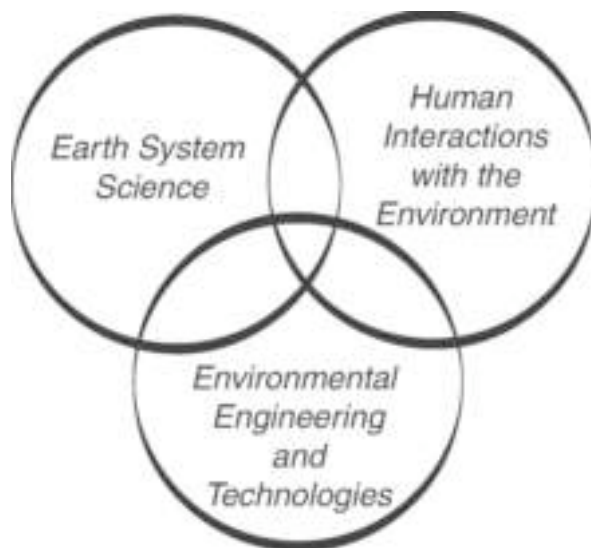
As we move into the 21<sup>st</sup> century we face significant challenges in gauging the human impact on our environment and in balancing the finite resources of our planet with growing populations and increasing standards of living. These challenges play out on local, regional, national, and global scales; they leave no one untouched. The state of the environment is and will be a major factor in determining human well-being.

That the environment is significant and likely to become more so is clear. Federal investment in the environment exceeds \$25 billion annually. The National Science Foundation supports over \$600 million in environmental research. This amount is projected to increase to \$1.6 billion over the next five years. The US Geological Survey invests over \$815 million in areas that include natural hazards and water resources. The EPA has an annual budget of over \$7.6 billion and invests over \$640 million in the 21<sup>st</sup> Century Research Fund directed toward the environment. The department of Energy has an annual budget of \$17 billion with \$8.3 billion directed toward Energy and Environment. Each of these agencies directs a substantial portion of their funds to external grants programs.

While federal programs support disciplinary research, a number of recent funding opportunities stress the need for a multidisciplinary perspective in coping with the environment. Shared characteristics of recent program announcements include: sound scientific assessment; analysis of heterogeneous and complex spatial and temporal data sets; use of tools and technology to monitor, manage, and remediate environmental systems; economic and social considerations; and education and communication between diverse constituents and stakeholders. Collectively, federal investment in the environment combined with state and local investments provide substantial sources of funding for environmental research and education programs.

Recognizing the growing importance of environment and the opportunities that already exist, we propose that Lehigh University marshal its existing strengths in this area and develop the Environment as a cross-cutting research and education thrust within the University. We propose that Lehigh establish an Environmental Institute to coordinate existing efforts and administer new programs in research and education. Lehigh's Environmental Institute would operate as an integral entity within the University to coordinate, promote, and develop Lehigh's Environmental portfolio. It would foster and facilitate multidisciplinary research and would oversee the administration of several multidisciplinary degree programs.

We take a broad view of the environment in order to encompass the spectrum of opportunities available to Lehigh, and to provide an intellectually compelling framework to organize our efforts. "Environment" is not merely a problem to be solved, but the intricate outcome when human affairs interweave with our natural surroundings. We present our proposal in the context of three interlocking themes:



*Thematic foundations of the Environmental Initiative*

*Earth Systems Science* examines the functioning of Earth and environment as an interrelated set of systems, using contributions from many disciplines such as ecology, geology, oceanography, and atmospheric science. Assessments of human impacts is an important part of Earth system science and leads to natural integration with many areas of the social sciences and engineering.

*Environmental Engineering and Technologies* represent an important link between humans, their economy and business, and the natural world. Work in this area can be broadly grouped into efforts to mitigate and respond to environmental problems, and efforts to prevent such problems in the first place through use of innovative and efficient engineering.

*Human Interactions with the Environment* encompasses all those means by which humans relate to and interact with their environment. It can be argued that many environmental issues ultimately fall into the realm of “no technical solution”, and human behavior, values, policy, economics, and philosophy all must contribute to finding a sustainable way forward.

These themes represent the three pillars on which human knowledge about the environment is based and they elegantly and efficiently encircle our significant existing research expertise as well as new areas with considerable potential and interest. Thus, these themes form the foundation for our proposed programs in research and education.

It is crucial for a modern university of Lehigh’s stature to address the environment in all its complexity. Most of our direct competitors for gifted students and external funding are putting in place environmental programs, and the most successful of these involve the cooperative efforts of numerous faculty operating across disciplines, departments, and colleges, backstopped by substantial application of university resources. Lehigh’s setting in a region that is a laboratory for environmental change, coupled with the university’s traditional and emerging strengths, leaves us with a wonderful opportunity to achieve a national reputation in environmental education and research. To do so will require an investment from the 2020 Fund to put in place the programs and scholars who can bring to bear viewpoints on the full range of this complexity. Building from this foundation, Lehigh will be able to make an impact within each of our theme areas, from synergies among these theme areas, and between the environmental initiative and other planned 2020 initiatives.

## **RESEARCH FOCI**

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Lehigh currently has strong environmental research expertise in place in two departments (Civil and Environmental Engineering, Earth and Environmental Sciences), as well as considerable, if isolated, faculty expertise scattered among a number of units and departments in all four colleges. Lehigh’s immediate need is to foster developments in integrated environmental

research and education. Lehigh's environmental portfolio must include research expertise in related areas, given the dynamic and interconnected nature of the environmental field, anticipated curricular needs, and the Environmental Initiative's broad mandate (see Dean's Charge, Appendix 1). It is possible to support research groups of sufficient strength to achieve prominence and be competitive nationally, particularly if we capitalize on existing programs and make links to other 2020 initiatives in Information Science and Technology, Materials, and Bioscience and Biotechnology.

We developed the following criteria to identify and evaluate areas of research expertise to fall under the EI umbrella:

- Does the area build on existing expertise?
- Does the area have the potential for funding?
- Does the area have the potential to be a rich area of scholarship?
- Does the area have synergy with other initiatives?
- Does the area fit with curricular goals?
- Is there graduate student demand?
- Is the area essential for Lehigh's presence as a university, or for the University to have a focus on the environment?

Using the above criteria, we recommend Lehigh develop an Environmental Research Portfolio that maintains and further develops areas in which Lehigh already has established expertise: Earth Dynamics and Natural Hazards, Environmental Change, Environmental Remediation, Advanced Treatment Processes and Energy Conversion Technologies, K-12 Environmental Education, Water and Watershed Systems. We further recommend that Lehigh move quickly to develop a strong research presence over a one to five year time frame in Environmental Policy Formation and Analysis, and Ecosystem Science and Engineering. Establishing this portfolio allows Lehigh to capitalize on existing strengths and resources as well as build expertise in new and promising areas.

Each research focus falls within one or more of the three broad theme areas: *Earth System Science*, *Environmental Technologies*, and *Human Interactions with the Environment*. While some of these research foci reside more in one theme area than another, each requires and benefits from a multidisciplinary approach and can draw on expertise from the other theme areas. Developing and maintaining these research strengths is critical to the long-term success and prominence of an environmental thrust at Lehigh.

## Lehigh's Environmental Research Portfolio

Earth Dynamics and Natural Hazards. That part of Earth-systems science concerned with the transfer of matter and energy within and between the solid-Earth, soil, ocean, atmospheric, ecosystem, and anthropogenic realms (e.g., volatile fluxes, climate change, feedbacks between the solid Earth and processes at the Earth's surface, and landscape evolution). Includes research into the threat, prediction, and mitigation of natural environmental hazards such as volcanoes, earthquakes, slope failure, flooding, and storms. Includes research on human perception of, communication about and response to natural hazards. Considerable expertise in this area exists with the Department of Earth and Environmental Sciences (EES).

Ecosystem Science and Engineering. The design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both. Ecological engineering combines basic and applied science from engineering, ecology, economics, and natural sciences for the restoration and construction of ecosystems. Examples include protection of wetlands and watersheds from municipal and industrial waste, reducing coastal erosion, flood control, ecosystems restoration, and coping with invasive species. A new and exciting area ripe for development. Lehigh has the potential to make an impact in this area.

Environmental Change. This area connects science and engineering issues with societal and governmental realms ranging from watershed through regional to global scales. Draws on expertise in EES, Civil and Environmental Engineering (CEE) and the social sciences. EES has expertise in climate change, landform evolution and impacts of environmental change on aquatic ecosystems and on plants. CEE has expertise in groundwater issues. Social science faculty have expertise in policy, development, risk communication and long-term views of human-environmental relations as evident in historical and archaeological records.

Environmental Policy Formation and Analysis. The social, cultural, political, economic, and psychological factors that shape environmental policies. These factors include social impact assessment, risk analysis, perception and communication of environmental problems, economic valuation, and decision making at global, national, state and local levels. Sustainable development and natural resource management are important potential foci in this area that would bring scientists and engineers together with social scientists. Required expertise includes international politics, policy analysis, economic analysis, risk analysis, risk communication, human perception of the environment and environmental problems, decision making, and human ecology. Development of research expertise in this realm is critical.

Environmental Remediation, Advance Treatment Processes, and Energy Conversion Technologies. This area includes development of advanced physiochemical and biological technologies for the remediation of contaminated earth materials, ground and surface waters, as well as development of advanced treatment processes for solid and liquid hazardous wastes and atmospheric emissions. It also includes the development of cleaner and more benign means of energy production and delivery, using enhanced designs, more efficient operational methods, and improved materials. The process improvements for these technologies require research in the areas of microbiology, hydrology, and physiochemical processes. Considerable expertise in this area exists with the Department of Civil and Environmental Engineering (CEE) and the Energy Research Center (ERC). Lehigh is poised to have a national presence in this area.

K-12 Environmental Education. The use of technology-based pedagogy in K-12 environmental education. Web-based inquiry in environmental education, Web-based instructional design, learning with hand-held data collection devices, use of data visualizations in instructional settings, and customizing assessment tools for environmental education are examples of some of the work underway at Lehigh. Applies to research conducted in Technology Based Teacher Education (TBTE) and Educational Technology (Ed Tech).

Water and Watershed Systems. Clean water is essential to Earth's populations. Understanding water resources and protecting and improving it through land management and treatment processes are critical to sustainable development. In addition, watersheds are an ideal scale at which to look at issues of development, planning and other governmental policies, human behavior and use factors, ecosystems dynamics and management, and specific impacts of regional and global environmental changes. Considerable expertise already on campus in EES and CEE; LEO provides already-established links to outside partners.

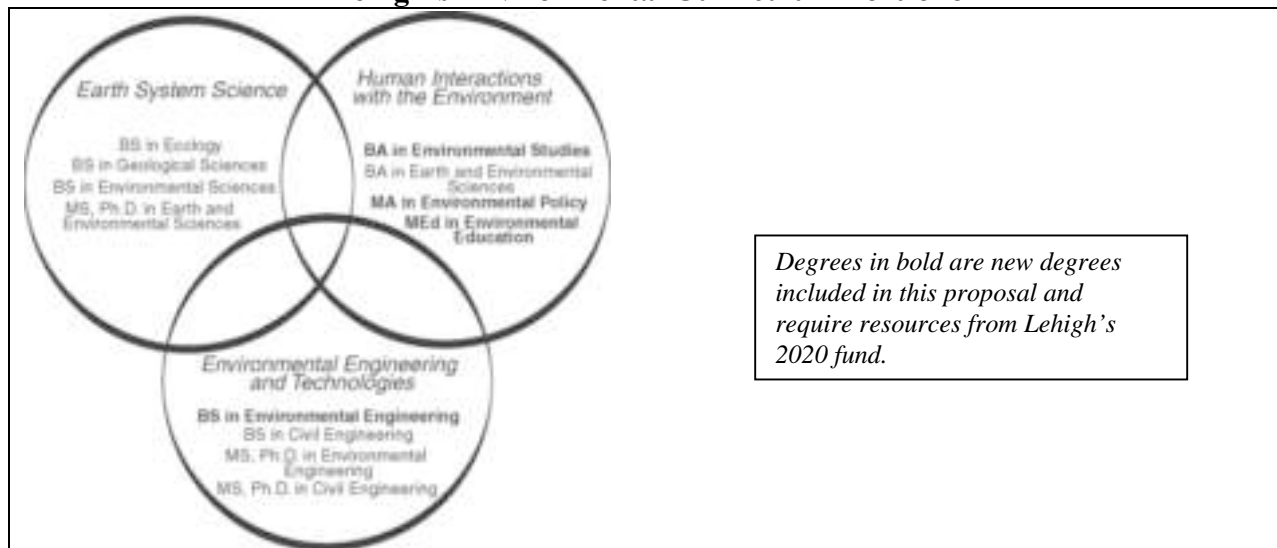
## CURRICULUM DEVELOPMENTS

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Environmental issues, problems, and opportunities, in all their importance and complexity, are of widespread interest to people at all levels of the educational spectrum. Lehigh has a special

opportunity and a responsibility, to educate the next generation of environmentally literate citizens, whether they become professional scientists, engineers, policy analysts, or poets. Failure to grasp this opportunity risks losing such environmentally inclined students to competing institutions of higher learning. Lehigh has long excelled at preparing both undergraduate and graduate level Earth and environmental scientists and civil engineers. Our programs in these areas have strong national reputations. However, we currently miss the opportunity to attract to Lehigh those highly qualified students who wish to pursue less technical environmental studies. Adding a BA degree in environmental studies and a MA in Environmental Policy puts in place a strong curriculum in each of the three foundation areas: *Earth System Science*, *Environmental Technologies*, and *Human Interactions with the Environment*. In addition we propose Lehigh offer a BS in environmental engineering, and a MEd in environmental education. Adding these four degrees fills gaps in our curricular offerings and makes available to Lehigh students the most comprehensive array of programs possible, ranging from the humanities and social science perspective, through the scientific, to the more technical in orientation.

### Lehigh's Environmental Curriculum Portfolio



#### **BA in Environmental Studies**

In keeping with the liberal arts tradition, the proposed Environmental Studies degree will provide broad exposure to the range of issues confronting the human condition, cultural and historical perspectives on how society has evolved to its present state, and insight into the range of possible corresponding methodological approaches and solutions to the global questions we confront. This degree will prepare students for a variety of career and graduate education options, ranging from corporate management or policy agencies to non-profit organizations or environmental law. As such, it is specifically designed to be broadly inclusive, rather than offering specialized training in an applied field. Training in an applied field is more appropriate at the graduate level.

The curriculum will consist of 75 credit hours for the major and an affiliated minor (described in detail in Appendix 3.2) divided into several major categories:

<b>Natural Science Core.</b> A minimum of 15 credits of natural science, including two laboratory courses (qualifies as a minor in EES) to ensure sufficient understanding of the underlying scientific bases of contemporary environmental challenges	<b>15 credits</b>
<b>Statistics and methods.</b> A statistics course and a social science research methods course to prepare students for understanding environmental risk and probability and developing appropriate data analysis and research design skills.	<b>8 credits</b>
<b>Environmental Studies Core.</b> Interdisciplinary courses designed to expose students to central issues and themes in the field of environmental studies. Includes capstone senior seminar.	<b>20 credits</b>
<b>Environmental Studies Electives.</b> Advanced courses in environmental studies.	<b>12 credits</b>
<b>LEO Internship.</b> Provides multidisciplinary experiential learning opportunity.	<b>4 credits</b>
<b>Affiliated Minor.</b> Affiliated disciplinary courses in a designated field (Political Science, Economics, International Relations, Communications, Anthropology, Environmental Thinking and Thought) provide disciplinary depth to complement the interdisciplinary core.	<b>16 credits</b>

### ***BS in Environmental Engineering***

The BS in Environmental Engineering is a technical, science, engineering, and mathematics-based degree. It is designed to extend to the undergraduate level the graduate program expertise currently available at the MS and PhD levels. Graduating students will be prepared to implement technology-based solutions to environmental problems; apply methods of modeling to assess, allocate and reduce risks; understand and quantify the fates of environmental pollutants; and modify/create processes for enhanced sustainability. Like other engineering disciplines, it provides a broad foundation in mathematics, the physical and social sciences, and the humanities. This interdisciplinary degree will meet ABET accreditation and will be administered by the department of Civil and Environmental Engineering. The proposed BS in Environmental Engineering would significantly overlap the BS in Civil Engineering program administered by the Civil and Environmental Engineering Department, consistently ranked among the top twenty-five programs in the country.

The curriculum will consist of 133 credit hours (described in detail in Appendix 3.3) divided into several major categories:

<b>Mathematics</b>	<b>17 credits</b>
<b>Science</b>	<b>26 credits</b>
<b>General Engineering</b>	<b>7 credits</b>
<b>CEE Env. Engineering</b>	<b>23 credits</b>
<b>CEE other</b>	<b>11 credits</b>
<b>Chemical Engineering</b>	<b>9 credits</b>
<b>Humanities &amp; Social Sci</b>	<b>23 credits</b>
<b>Electives (Tech. &amp; Free)</b>	<b>17 credits</b>

### ***MA in Environmental Policy***

At the graduate level we propose a new MA in Environmental Policy. This degree leverages efforts at the undergraduate level and complements existing graduate degree programs in Environmental Engineering and Earth and Environmental Sciences. The degree program will focus on policy issues and analysis but will also include exposure to economics and geographic information systems (GIS) skills of a more technical management degree, as well as to

environmental ethics and history of a more humanistic program. The MA in Environmental Policy is designed to provide a graduate degree opportunity for those students interested in either a professional terminal degree or in some cases for those who might wish to continue on for a PhD at another institution. The degree is designed to expose students at an advanced level to a range of topics and skill sets that they will find useful throughout their careers, which might include private industry, government agencies, and non-governmental organizations.

The MA in Environmental Policy consists of 30 credits. They are divided into a set of core courses required of all students, required courses to provide disciplinary breadth (may be waived based on a student’s previous educational background or work experience), and a range of elective choices to meet the total credit requirement. Additional details of the proposed MA in Environmental Policy are detailed in Appendix 3.4.

<b>Core Courses.</b> Five 3 credit core courses cover major issues and themes in the field: advanced environmental policy, risk perception communication and analysis, environmental economics, and GIS.	<b>15 credits</b>
<b>Disciplinary Breadth.</b> Students are required to take additional courses in policy and statistics, environmental science, and environmental technology.	<b>9 credits</b>
<b>Advanced electives.</b> Two courses are required, one in the general humanities/social science area—ethics, history, law, and one advanced skills level course—environmental impact assessment, environmental regulations, economics.	<b>6 credits</b>

***MEd in Environmental Education***

In Pennsylvania, as in many states, most K-12 teachers must continue to participate in professional development to renew their teaching license. This master’s program will service the desire of K-12 teachers to earn an advanced degree and serve the demand for training in environmental education created by the adoption of the Pennsylvania Academic Standards for Environment and Ecology (PDE, 2001) that defines what knowledge and skills all Pennsylvania students should know and be able to do in nine environmental topic areas. The proposed new degree program would require 30 semester hours of credit and be offered under a non-thesis option. This degree would be available to those who currently hold teaching credentials.

<b>Core courses.</b> Two courses including education principles and web based inquiry within the context of environmental education.	<b>6 credits</b>
<b>Technology Based Teaching and Learning.</b> One course in foundations and issues and one in methods and assessment.	<b>6 credits</b>
<b>Disciplinary Breadth.</b> Students are required to take additional courses in environmental science and technology.	<b>12 credits</b>
<b>LEO Inquiry based education and learning experience.</b>	<b>6 credits</b>

The master of education in environmental education degree would be structured to provide both depth and breadth in a variety of relevant basic and advanced study opportunities. All students will be required to complete a core of four education courses augmented by environmental science and technology course offerings that are currently proposed as part of the MA in Environmental Policy. Details of the MEd in Environmental education can be found in Appendix 3.5.

## **SYNERGISTIC OPPORTUNITIES**

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Our efforts in research and education can be leveraged to reach a broader non-traditional student, the student interested in continuing education, developing new skills, or acquiring new knowledge to help meet career goals. We propose to attract and meet the needs of these students by three different methods: 1) Professional Certification Programs, 2) Short courses, and 3) K-12 Environmental Educational Outreach. These programs should draw on the interests and expertise of Lehigh faculty and would be coordinated and marketed through the environmental institute.

### ***Professional Certification Programs***

Each certificate program would consist of four three-credit courses for a total of 12 credits. These courses would be drawn from existing courses that are part of regular graduate degree offerings. Students receiving a professional certificate would be eligible to enroll in an established Master's program offered through the environmental institute or in core departments. Grades and credits from the certificate program could be applied toward graduation requirements. While some courses would be offered in residence, others could be offered on-line.

We propose that the Lehigh initially offer four certification programs through the environmental institute:

- Geographic Information Systems (GIS) certificate
- Environmental Education certificate
- Water Quality Assessment certificate
- Environmental Journalism certificate

Details of these certificate program are included in Appendix 3.5. Additional certificate programs such as Hazardous Waste Management and/or Risk Assessment can be developed as the EI evolves. A certificate in Environmental Policy would be a natural addition once the MA in Environmental Policy is established.

### ***Short courses***

Short courses could be offered for Continuing Education Units. These could be 1-3 day workshops or 1-week intensive courses. They would draw from a local clientele, but in some instances could attract a national or international audience. Short course offerings should be linked to other content areas in the environmental initiatives, building on faculty expertise. Examples of short courses that could be offered include:

- Applications of GIS for managing environmental data for local municipalities
- Methods in water quality analysis
- Wetlands restoration
- GIS Applications for Journalists
- Risk Communication
- Environmental Writing Techniques
- Translating Scientific Data from Environmental Studies for Written Reports and Oral Presentations to Laypeople

- Environmental Perception, Visual Thinking and Environmental Writing
- Environmental Education (K-12 teachers; see list in section below)
- Environmental Risk Assessment

Additional offerings might include the following topic areas depending on faculty interest: Environmental Microbiology; Environmental Geophysics; Waste remediation; In-situ electrokinetic treatment of contaminated Porous Media; Computer-based numerical modeling of flow; Storm water management and urban hydrology; Culvert design; and Hydrology and hydraulics; Management of invasive species.

### **K-12 Environmental Educational Outreach**

In Pennsylvania, as in many states, most K-12 teachers must continue to participate in professional development to renew their teaching license. Specifically K-12 teachers are required to earn renewal certification hours - Act 48 requires all Pennsylvania educators holding Pennsylvania public school certification to participate in ongoing professional education. In addition, the adoption of the Pennsylvania Academic Standards for Environment and Ecology (PDE, 2001) will lead to demand for teacher training in Environmental Education.

K-12 environmental education outreach aligns well to the research interests of the College of Education in the areas of Web-based instructional pedagogy and professional development. Furthermore, it builds on existing LEO K-12 outreach initiatives and existing partnerships with environmental education organizations such as the Wildlands Conservancy. The Lehigh environmental institute can offer a variety of professional development experiences for teachers. Examples of offerings include:

- GIS courses for educators using LEO environmental data and regional GIS coverages.
- Fundamentals of Environmental Education
- Series of one-three day short courses for teachers in topic areas that include: hands-on environmental science for elementary, middle and secondary school teachers; and Web-based inquiry for environmental science with a focus on using the activities on the LEO Website (for example LEO EnviroSci Inquiry).

## **ADMINISTRATION**

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A multidisciplinary initiative of the proposed scale, crosscutting departments and colleges, requires a full-time Director to oversee, manage, and coordinate activities. The director of Lehigh's environmental institute will need to have a clear vision of the importance of the environment in human affairs and an established record of research and teaching in one of the three theme areas: *Earth System Science, Engineering Technologies, or Human Interactions with the Environment*. The director must have a documented commitment to multidisciplinary study of the environment, to integrating education and research, and to establishing partnerships with diverse constituencies (universities, industry, government agencies, non-profit organizations, etc...), and a strong record of external funding.

We recommend that the environmental institute not fall under a single college. Its director will need to work in close cooperation with the all the Deans, the Vice Provost for Research, and the

chairs of core departments to evaluate and set goals and priorities. Placing the institute and its director within the administrative structure of a single college would undermine the multidisciplinary nature of the enterprise; all involved parties need to be vested in the success of the environmental institute if it is to thrive. We recommend that the Director of the Environmental Institute report jointly to the Deans of the College of Arts and Sciences and the Rossin College of Engineering and Applied Sciences.

Faculty hires using 2020 funds should receive joint faculty appointments between the environmental institute and an existing core or affiliated department (see definitions below). Guidelines for hiring and evaluation of these faculty will follow the existing University Joint Appointment Policy. Performance standards, and teaching and research expectations need to be clearly defined in writing in the initial appointment letter. A faculty committee made up of faculty from the environmental institute and the home department should constitute faculty input to the reappointment, tenure and promotion process.

We recommend both new and existing environmental activities at Lehigh be grouped under an umbrella provided by the environmental institute. An umbrella structure provides visibility for environmental activities, helps build critical mass, facilitates synergistic activities, and leverages infrastructure. Faculty and departmental involvement in the environmental institute would be classified as follows:

*Core Departments or Faculty.* Faculty and departments whose mission, goals, research, and teaching are closely aligned with and significantly overlap the environmental institute. This classification could apply to whole departments or to an individual faculty member in an affiliated department.

*Affiliated Departments or Faculty.* Faculty and Departments with clear links and focused efforts in environmental curriculum and research areas associated with the environmental institute. While these departments/faculty may teach or support courses in the environmental curriculum and contribute to research foci under the institute umbrella, they also have interests and make contributions in areas outside the institute's umbrella.

*Contributing Departments or Faculty.* Faculty and Departments with interest in the environment and making links or contributing to institute activities as interest and time permits.

Department and faculty participation in all three classifications are important to the success of environmental institute. Core departments and both core and affiliated faculty should have a voice in the growth and development of the environmental institute as described below (see *Organization and Governance*). Core Departments would retain their autonomy under the environmental-institute umbrella. Faculty in these departments would report to the Chairs of their departments. Chairs of these departments would report directly to the Dean of their college. Department budgets would remain intact. Existing Lehigh faculty, at their own initiation, could ask that their existing appointments be converted to a joint appointment between their home department and the environmental institute. Conversion of an existing appointment could only

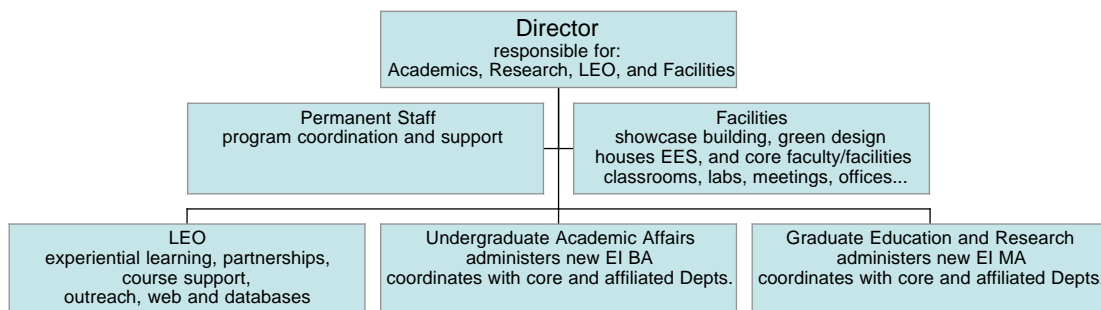
take place if the process is initiated by the faculty member, and would follow existing University policy as described in the Joint Appointment Policy.

***The Lehigh Earth Observatory, LEO***, would maintain its distinct identity but would fall under the umbrella of the environmental institute. LEO would continue its ongoing efforts, providing multidisciplinary experiential learning opportunities for Lehigh students, providing infrastructure support and archive capabilities for courses with environmental content, providing a web interface to environmental activities at Lehigh, monitoring a variety of environmental systems, and collecting a variety data and data types into a regional environmental data center, but its staff and operating budget would come under the purview of the environmental institute director. Under the environmental institute, LEO would also serve to coordinate outreach activities, short courses, and certificate programs.

***Existing Centers and Institutes*** at the University with interest and effort in the environmental arena can choose to be part of the environmental institute with either core, affiliated, or contributing status.

***Organization and Governance.*** The director, in association with faculty and permanent staff, will provide oversight and management of the environmental institute. Both core and affiliated faculty will have a voice in growth and development of the environmental institute in much the same way faculty function in existing departments (participation in regularly scheduled faculty and staff meetings, faculty searches, etc.). The institute and core departments should jointly administer facilities that fall under the umbrella of the environmental institute. Three faculty/staff subcommittees, chaired by faculty, will help coordinate and oversee educational and research activities under the environmental institute umbrella: 1) LEO (coordinates experiential learning, course support, outreach activities, web, and data bases), 2) undergraduate academic affairs, and 3) graduate education and research. The Chairs of each subcommittee, along with the Chairs of Core Departments (or their designee) and the environmental institute director will make up a Steering Committee that meets on a regular basis to provide coordination between ongoing efforts.

### EI Organizational Structure



***Degree Programs.*** The environmental institute will coordinate two new interdisciplinary degree programs, the BA in Environmental Studies and the MA in Environmental Policy and requests resource support for the BS in Environmental Engineering and MEd in Environmental Education

(although these programs will be administered by the CEE Department and the College of Education respectively). These new degree programs will draw on new courses offered under the EI rubric as well as existing courses offered by core, affiliated, and contributing departments. All parties contributing to these degrees need to be vested in their success. Individual faculty teaching this suite of courses need to receive credit and recognition for course offerings. Both the environmental institute and home department also need to receive credit/recognition for their support and participation.

## **IMPLEMENTATION (Hiring, Facilities, Staffing)**

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Establishment of a critical mass of environmental effort at Lehigh should be viewed as a two-stage process. An immediate investment of 2020 funds is required to secure Lehigh's commitment to environmental research and instruction. In parallel but on a longer time line, this initial investment should be augmented and supported using reallocated resources, proportionate to the success of the initial investment and the student interest it generates.

### ***Proposed New Faculty Hires – Phase I***

Twelve new faculty hires (including the Director) in the following areas are required to establish a national presence in the area of the environment:

- Ecosystems engineer/ecologist: Ecosystems ecologist with applied experience in such areas as systems analysis and ecological modeling, restoration ecology, biogeochemistry, and surface-water hydrology.
- Environmental economics: Evaluation of economic systems as applied to the environment. Research areas include, but not limited to, economic causes and consequences of environmental changes; tax and regulatory policies that affect the environment; markets for pollution rights and related issues; government policies toward the environment; valuation of environmental resources, "green accounting" and intergovernmental cooperation in environmental policy.
- Environmental engineering and technology: Engineer with expertise in technological innovations to improve efficiency and reduce the environmental impact of systems that convert energy sources (coal, oil, gas, etc.) into other forms of energy (electricity, work, heat). The addition of a faculty member in the areas of trace contaminants and/or global warming gases from combustion sources (power plants, vehicles, etc.) would greatly compliment and enhance Lehigh's research in these areas. The successful candidate is one who could use fundamental and scientific approaches to understanding the formation, transport and fate of these pollutants as well as the technologies used to reduce them.
- Environmental policy – domestic: Expertise in historical and political processes involved in environmental policy and regulation; environmental planning and design regarding land use and urban sprawl; and/or problem-focused policy studies in such areas as coastal zone management, endangered species, energy issues, resource use and waste policy and management, etc.
- Environmental policy – international: Expertise in the web of international institutions, international law and diplomacy among national governments that constitute the international environmental regime; comparative national economic environmental policies; and the main international actors, including national governments, international institutions, non-governmental organizations, and cross-national groups of scientists, analysts and social and political activists.
- Fate and transport of trace contaminants: Engineer with expertise in the physical and chemical interaction with soil and constituents in surface/groundwater and microbial transformation and/or transport of this material through the soil/surface/groundwater system.

- Remote sensing and image analysis: Scientist who has demonstrated innovative use of satellite and other remotely sensed data to gain synoptic understanding of earth systems and human interactions with them. We would be particularly interested in individuals who have worked across traditional disciplinary boundaries and who have expertise in one or more of the areas of active tectonics, natural hazards, surficial processes, environmental change, and landscape or ecosystems ecology. Expertise in Geographic Information Systems (GIS) would be expected.
- Risk analysis, perception, and communication: Expertise in risk communication and perception, in particular, in interrelationships with and among individuals, communities, governments, and the media involved in communicating about risks; social amplification of risk and stigmatization; and human responses to natural and man-made environmental hazards. Individual also should have a broad understanding of risk analysis.
- “Critical-zone” science/Geomicrobiology: Biogeochemist, soil ecologist, or soil scientist interested in processes in the “critical zone,” the near-surface environment in which living organisms, rock, water, soil interact. Or Scientist with expertise in role of microbial communities in mediating environmental processes like weathering, mineralization and concentration of resources, biogeochemical cycling, and degradation of anthropogenic contaminants.
- Environmental Values and Decision Making: Expertise in holistic analysis of social systems with focus on humans' cultural and behavioral adaptations to their environments; relations between human values, exploitative systems, and consumption patterns; maladaptations arising from dilemmas of rational choice (e.g. *Tragedy of Commons* problems); decision making under conditions of uncertainty and risk at both individual and group levels.
- Environmental Science Education Specialist: Expertise in environmental science education at the K-12 level.

All of these hires are expected to conduct research and participate in curricula that fall under the environmental institute’s umbrella. The hires outlined above can contribute to research in one or more research foci and will contribute to proposed and existing degree programs as illustrated in the table on the following page. Courses offered by these new hires will also enrich the curriculum for existing degree programs by providing new courses in allied fields to help fulfill distribution requirements and electives.

Each of these hires is relatively broadly defined, allowing departments and faculty search committees to find the best possible faculty within an area, without overly constraining the search. We recommend that several hires, particularly in the social sciences be at associate or full professor level to help jump-start efforts in that area. We note that for many of these hires there are several departmental homes that could be appropriate. It should be made clear that these faculty have a formal commitment to the Lehigh’s environmental institute.

<p style="text-align: center;"><b><u>New Hires</u></b> →</p> <p style="text-align: center;"><b>Contributions</b></p> <p style="text-align: center;">↓</p>	Ecosystems engineer/ecologist	Environmental economics	Environmental engineering and technology	Environmental policy - domestic	Environmental policy - international	Fate and transport of trace contaminants	Remote sensing and image analysis	Risk analysis, perception, and communication	"Critical-zone" science or geomicrobiology	Environmental Values and Decision Making	Science Education Specialist
<b>Research Foci</b>											
Earth Dynamics and Natural Hazards											
Ecosystem Science and Engineering											
Environmental Policy Formation											
Environmental Change											
Environmental Remediation, Advance Treatment Processes, and Energy Conversion Technologies											
K-12 Environmental Education											
Water and Watershed Systems											
<b>New Curriculum</b>											
BA in Environmental Studies											
MA in Environmental Policy											
MEd in Environmental Education											
<b>Existing Curriculum</b>											
BS in Geological Sciences											
BS in Environmental Sciences											
BS in Ecology											
BA in Earth and Environmental Sciences											
MS in Earth and Environmental Sciences											
PhD in Earth and Environmental Sciences											
BS in Environmental Engineering											
MS in Environmental Engineering											
PhD in Environmental Engineering											

We recommend that the hires be prioritized and brought on-board at various ranks as follows:

	Year 1	Year 2	Year 3	Rank
Ecosystems engineer/ecologist				Assistant
Environmental economics				Associate
Environmental engineering and technology				Assistant
Environmental policy - domestic				Assistant
Environmental policy - international				Full
Fate and transport of trace contaminants				Assistant
Remote sensing and image analysis				Assistant
Risk analysis, perception, and communication				Associate
“Critical-Zone” science or Geomicrobiology				Assistant
Environmental Values and Decision Making				Assistant
Environmental Science Education Specialist				Associate
Director				Full

***Proposed Faculty Hires – Phase II***

A fully realized environmental thrust at Lehigh will require a second phase of growth, as our proposed programs take root, and cross-disciplinary scholarship and research in the environment are nucleated. In the years to come, Lehigh will be working through its capital campaign and will also experience a number of faculty retirements. We recommend that some of these future dollars should be directed towards Phase II growth of the Environmental Initiative as one of Lehigh’s signature research and teaching focus areas. Additional hires should be made based on joint recommendations between the environmental institute and its core and affiliated departments. Future hires may include, but not be limited to, the following disciplines:

- Regional planning
- Environmental ethics
- Environmental law
- Environmental regulations
- Atmospheric chemistry
- Environmental geophysics
- Biogeochemistry
- Geotechnical engineering
- Compatible development
- Green design in architecture and landscape design
- Design Science
- Coastal processes
- Active Tectonics
- Environmental health
- Environmental technology

In the short-term, some of the above expertise could be made available through partnerships, adjuncts, and other cooperative arrangements.

In addition there are areas of skills and expertise that are important in supporting and integrating the environmental initiative. While some of this expertise might already exist at Lehigh, either it is not directed toward environmental inquiry or it does not exist in sufficient strength or quantity. The following skills and expertise should be considered as additional modifiers for new faculty hires in both Phase I and Phase II:

- Communication

- Computational modeling
- Data management and visualization
- Instructional design
- GIS & database
- Nonlinear systems analysis

### **Facilities**

While the marvels of the Internet and video conferencing make close physical proximity less of an issue than in the past, the truly multidisciplinary integration of research and education envisioned in this proposal requires that the faculty and students engaged in this enterprise be located together in a single facility. A new building housing the environmental institute should reflect the University's commitment to this enterprise. It should be a showcase building incorporating elements of green design. It should be aesthetically pleasing, adding to and drawing from the natural beauty of Lehigh's campus. The building would house teaching and laboratory space; faculty and staff offices; offices for graduate students, post docs, and research fellows; computer labs, analytical facilities; and support facilities: conference and meeting room space, common space where undergraduates can work, and common space where faculty, staff, and students meet and interact. Such an arrangement will facilitate interactions and development of synergies and will lead to efficient and effective provision of research support in terms of physical plant and technical staff. The institute and core departments should jointly administer facilities that fall under the umbrella of the environmental institute. Core departments that may be housed within the new building will need dedicated space to carry out their mission and departmental functions that are distinct from EI activities. This new building, currently the top priority for Lehigh, is not a formal part of our Environment 2020 proposal, but is an essential component that needs to go forward in parallel with this initiative.

### **Support Staff**

We anticipate a total of six permanent staff will be required to support the environmental institute: 1) an administrative assistant/coordinator, 2) a GIS, database, web manager, 3) technical and supervisory support for course work, laboratories, and field projects monitoring environmental systems, 4) an education and outreach coordinator, 5) systems manager, 6) technical support for new analytical facilities. Staff position 2 and 3 are funded through LEO. These existing positions should be transferred to the environmental institute and support functions provided by these positions should continue. Staff position 4 will be required to help with the new MEd program and with the K-12 education activities described in the synergistic opportunities section and in Appendix 4. Faculty and students associated with the environmental institute will be require significant computer resources (e.g. for GIS and a variety of other applications) and a core set of analytical facilities (e.g., ICP-MS and trace-level analysis). Synergies with other initiatives (e.g. Materials, Bioscience/Biotechnology) and other units (e.g. Library and Technical Services) should be investigated, but it is likely that centralized facilities will be required, and these will require technical support. Staff position 5 will be required to support the computational needs in research and education associated with the institute. This position could be allocated directly to the institute or to LTS (Library and Technical

Services), but we anticipate the need for full time and dedicated support, someone who fully understands the software and hardware support needs of the institute. The details of position 6 will be determined by the specific hires made through the environmental initiative, but we anticipate the need for technical support for analytical facilities associated with the institute.

### **Postdoctoral Research and Research Fellow Positions**

We propose the environmental institute support a total of five positions to be awarded to postdoctoral researchers or research fellows. These positions should be awarded for an initial 3-year fixed term, and could be extended to a maximum of 5-years. These individuals would be on the cutting edge in research areas of interest to the institute. They would catalyze and advance the research goals and reputation of the institute. In addition these individuals would be expected to teach one course per year in the area of their expertise. These positions would be applied for by groups affiliated with the environmental institute; on completion they would return to the institute for either renewal or redistribution.

The benefits of such positions are many. They provide the institute with fresh perspectives and up-to-date expertise, and they provide role models that bridge faculty, graduate, and undergraduate students. People in such positions tend to be highly productive. By residing for terms longer than the standard two-year postdoc, it is possible for people to become more engaged in their work and to secure funding. Further, such positions provide Lehigh with an agile means of exploring new areas, or providing support where it is urgently needed, without pinning down resources into a long-term faculty slot. To avoid any suggestion that these positions are simply an attempt to obtain less-expensive labor, these positions should be clearly offered as fixed-term career-development positions, with competitive salaries and full benefits. Although it is not clear that such a group could be entirely self-sustaining, it is likely that a significant fraction of their costs could be recovered via grants and contracts, and the catalytic effect such positions might have should not be underestimated. The benefits of these positions will be closely monitored and their contribution to graduate cash tuition and ICR revenue assessed. This assessment will need to consider both enhancements in reputation as well as revenue streams. Enhancement in revenue should include not only the funds generated directly by the Post-Doc/Research Fellows, but also funds generated by enhanced faculty productivity on grants on which the Post-Doc/Research Fellows actively collaborate as Co-PIs. Finally, it would seem likely that foundation support for some of these positions might be obtained, using the hard-money lines as matching funds.

### **LINKS TO OTHER 2020 INITIATIVES**

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Coordination with other 2020 initiatives needs to be carefully considered, as there are research areas where these initiatives could augment one another's breadth or depth of expertise. Some examples:

- Energy conversion (e.g. fuel-cell technology), with Materials

- Geomicrobiology and Bioremediation, with Materials and Biosciences/Biotechnology
- Data mining and visualization, with Information Sciences and Technology

## **SUMMARY OF BUDGET REQUEST AND PROJECTIONS**

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We are requesting \$5.25 million of expenditures over a ten-year period to implement our proposed environmental institute. This request breaks down as follows:

- 2.2 million for one-time expenses (equipment, start-up, renovations)
- 2.76 million for initial coverage of ongoing expenses (faculty, research, and staff salaries, teaching assistants, operations, library allocations, etc.)
- \$290K in salaries for postdoctoral researchers and research fellows.

Our budget model (budget model e) indicates that our proposed program reaches steady state after 10 years. Continuing operational costs including the operating budget of the institute, department expenses for faculty growth, support staff and TA salaries, etc., stabilizes at ~\$673K. These expenditures are offset by \$667 in new revenue generated by ICR, graduate tuition, and certificate programs.

We are confident that a strong Phase I environmental institute could firmly establish Lehigh University's national reputation in the area of the environment, attract high-quality undergraduate and graduate students to study at Lehigh, and could be a source of revenue for the university. We envision Phase II growth of Lehigh's environmental thrust to be opportunistic, and reflect the success of the initiative, and the nature and extent of engagement of others within Lehigh. We envision (re)allocation of positions from retirements, income from development efforts, and surplus income from environmental-institute programs will provide the resources needed for Phase II growth.