FAU
BOARD OF TRUSTEES
Florida Atlantic University

Item: AS: A-4

COMMITTEE ON ACADEMIC AND STUDENT AFFAIRS

Tuesday, June 4, 2019

SUBJECT: REQUEST FOR APPROVAL OF A NEW DEGREE PROGRAM - CIP 14.9999

PROPOSED COMMITTEE ACTION

Request for approval of the following New Degree Program – CIP 14.9999:

- Ph.D. in Transportation and Environmental Engineering

BACKGROUND INFORMATION

The proposed new Ph.D. degree program in Transportation and Environmental Engineering responds to the critical emerging need to address two major, interlinked and interdependent systems (i.e., transportation and environmental systems) that impact the reliability, resiliency and sustainability of our current and future built and natural environments. The primary goal of the program is to allow students to perform specialized training and research, resulting in a degree that recognizes the student's scholarly competence and their ability to practice, conduct and report original and significant transportation and environmental engineering research. This Ph.D. program will serve Florida's needs by enabling the state to advance, via research and creation of new information and technology, a knowledge-based economy to manage the many environmental stressors on its water, land, air resources and transportation infrastructure, which impacts social and economic opportunities for current and future generations. The proposed Ph.D. program will encompass the fields of transportation engineering and environmental engineering, which is consistent with pressing needs of the state of Florida and the nation.

There are two paths proposed to achieve the Ph.D. degree. The first is the traditional path, which requires both the B.S. and M.S. degrees, and the second path is the direct BS to Ph.D. The program requires a minimum of 72 post baccalaureate credits hours including 21 credit hours of specialized coursework, 21 credit hours of dissertation research, and up to 30 credit hours from a master's degree in a closely related field that is consistent with the admission requirements.

IMPLEMENTATION PLAN/DATE

Effective Summer 2020, pending approval by the Florida Atlantic University Board of Trustees.

FISCAL IMPLICATIONS

With the recent faculty hires in environmental and transportation engineering for the 2019-2020 academic year, faculty staffing in the Department is sufficient to initiate the program. The faculty salary and benefits needed to support this program will come entirely from reallocated base E&G funds. For Year 1, the budget includes $225,916 in funds reallocated from the Department to fund faculty salaries and benefits for the current faculty members in the program, and the recent new faculty members being hired on vacant lines. The reallocated salaries and benefits extend into the fifth year and include any increases in percent effort for current faculty as well as salaries and benefits for two new faculty members (one starting in Fall 2021 and one starting in Fall 2023), for a total of $516,370 for Year 5.

Supporting Documentation: New Degree Proposal Form
Presented by: Dr. Bret Danilowicz, Vice President for Academic Affairs & Provost
Phone: 561-297-6350

Board of Governors, State University System of Florida
Request to Offer a New Degree Program

(Please do not revise this proposal format without prior approval from Board staff)

Florida Atlantic University	**Summer 2020**
University Submitting Proposal	**Proposed Implementation Term**
College of Engineering and Computer Science	**Civil, Environmental & Geomatics Engineering (CEGE)**
Name of College(s) or School(s)	**Name of Department(s)/ Division(s)**
Engineering, Other	**Ph.D. with Major in Transportation and Environmental Engineering**
Academic Specialty or Field	**Complete Name of Degree**
14.9999	
Proposed CIP Code	

The submission of this proposal constitutes a commitment by the university that, if the proposal is approved, the necessary financial resources and the criteria for establishing new programs have been met prior to the initiation of the program.

Date Approved by the University Board of Trustees		**President**	**Date**
Signature of Chair, Board of Trustees	**Date**	**Vice President for Academic Affairs**	**Date**

Provide headcount (HC) and full-time equivalent (FTE) student estimates of majors for Years 1 through 5. HC and FTE estimates should be identical to those in Table 1 in Appendix A. Indicate the program costs for the first and the fifth years of implementation as shown in the appropriate columns in Table 2 in Appendix A. Calculate an Educational and General (E&G) cost per FTE for Years 1 and 5 (Total E&G divided by FTE).

Implementation Timeframe	Projected Enrollment (From Table 1)		Projected Program Costs (From Table 2)				
	HC	FTE	E&G Cost per FTE	E&G Funds	Contract & Grants Funds	Auxiliary Funds	Total Cost
Year 1	14	10	$22,592	$225,916	$68,000	$0	$293,916
Year 2	18	13					
Year 3	23	17					
Year 4	29	22					
Year 5	35	26	$19,860	$516,370	$170,000	$0	$686,370

Note: This outline and the questions pertaining to each section must be reproduced within the body of the proposal to ensure that all sections have been satisfactorily addressed. Tables 1 through 4 are to be included as Appendix A and not reproduced within the body of the proposals because this often causes errors in the automatic calculations.

INTRODUCTION

I. Program Description and Relationship to System-Level Goals

A. Briefly describe within a few paragraphs the degree program under consideration, including (a) level; (b) emphases, including majors, concentrations, tracks, or specializations; (c) total number of credit hours; and (d) overall purpose, including examples of employment or education opportunities that may be available to program graduates.

The proposed new Ph.D. degree program responds to the critical emerging need to address two major, interlinked and interdependent systems (i.e., transportation and environmental systems) that impact the reliability, resiliency and sustainability of our current and future built and natural environments. Also, these two systems are most prone to anthropogenic influences that significantly affect regional scale economic conditions. Transportation networks combined with proper infrastructure convey socioeconomic benefits, yet they impact the environment and human health in direct and indirect ways. Conversely, environmental factors and conditions can also control how transportation systems are implemented. The major link between these two competing systems and their contributions to the economy is dependent on a sustainable, robust, safe, secure, energy-efficient, and economically viable built infrastructure. The proposed combined Transportation and Environmental Engineering Ph.D. program aims to seamlessly blend the interdependency of transportation and environmental system linkages to address critical challenges that enable the well-being of one or both systems through multidimensional research that merges traditional transportation and environmental engineering together as a single system.

(a) Level: Florida Atlantic University (FAU) proposes to offer a Ph.D. with Major in Transportation and Environmental Engineering. This program will build upon and expand the success of the current sustainable infrastructure track offered within the Ph.D. with Major in Ocean Engineering, making it a broader combined program that integrates transportation engineering and environmental engineering issues.

(b) Emphases: FAU has strategic pillars that are institutional unit-engaged activities that create new knowledge to benefit society. Two of the pillars of the university are directly aligned to this proposed doctoral degree program. I-SENSE, which is the Institute for Sensing and Embedded Network Systems Engineering that supports advancements in computing and sensing technologies targeted toward infrastructure systems, marine and environmental systems, and human health/behavior. The other pillar is the Harbor Branch pillar for ocean science and engineering/environmental sciences research effort. The Department created two strategic focus groups for strengthening emerging research and better engage with the university pillars: 1) urban mobility and 2) environmental sustainability.

(c) Total number of credit hours: There are two paths proposed to achieve the Ph.D. degree. The first is the traditional path, which requires both a B.S. and M.S. degree, and the second path is the direct BS to Ph.D. The program requires a minimum of 72 post baccalaureate credits hours including 21 credit hours of specialized coursework, 21 credit hours of dissertation research, and up to 30 credit hours from a master's degree in a closely related field that is consistent with the admission requirements. There is currently no Ph.D. program with the CIP code 14.9999 in the SUS.

(d) Overall purpose: The degree program engages a diverse group of faculty from engineering, science, urban planning and management disciplines to address issues aligned with the FAU's research pillars. This Ph.D. program will supplement and support the research efforts at FAU in the fields of urban mobility and water resources/environmental sustainability, as well as ongoing activities at the Harbor Branch and I-SENSE pillars. The primary goal of the Ph.D. in Transportation and Environmental Engineering program is to allow students to perform

specialized training and research, resulting in a degree that recognizes the student's scholarly competence and their ability to practice, conduct and report original and significant transportation and environmental engineering research. This Ph.D. program will serve Florida's needs by enabling the state to advance, via research and creation of new information and technology, a knowledge-based economy to manage the many environmental stressors on its water, land, air resources and transportation infrastructure, which impacts social and economic opportunities for current and future generations. The proposed Ph.D. program will encompass the fields of transportation engineering and environmental engineering, which is consistent with pressing needs of the state of Florida and the nation. The Department of Civil, Environmental and Geomatics Engineering (CEGE) at FAU is a research and teaching unit created in 2009 as a result of merging the Civil Engineering and Geomatics Engineering programs. The Department consists of nationally and internationally well-known faculty members with diverse and extensive experience in research, teaching, and graduate student education and mentoring. This new Ph.D. program in Transportation and Environmental Engineering is specifically tailored to meet the changing needs of the university's service region as well as the State and national priorities as identified by federal and state agencies and industry. Graduates will be rigorously prepared for careers in professional practice, regulatory agencies, research laboratories, academia, and specialized job functions in engineering, management, government, and consulting. CEGE faculty are responsible for $2.6 million in external research funding (FY2017-18), providing a solid base for student support, and the proposed doctoral program will provide significant leverage to help double research expenditures by bringing more national/state research centers like our Tier 1 University Transportation Center supported by USDOT, as well as our other research labs and centers: Freight Mobility Research Institute (FMRI), Laboratory for Adaptive Traffic Operations and Management (LATOM) at the Transportation Engineering Research Hub, Hydrosystems Research Laboratory (HRL), and the Laboratories for Engineered Environmental Solutions (Lab.EES).

B. Please provide the date when the pre-proposal was presented to CAVP (Council of Academic Vice Presidents) Academic Program Coordination review group. Identify any concerns that the CAVP review group raised with the pre-proposed program and provide a brief narrative explaining how each of these concerns has been or is being addressed.

The pre-proposal was presented to CAVP on February 22, 2019. No concerns were raised at the meeting.

C. If this is a doctoral level program please include the external consultant's report at the end of the proposal as Appendix D. Please provide a few highlights from the report and describe ways in which the report affected the approval process at the university.

As indicated in Appendix D, Hanover Research, an independent external consultant firm, provided a comprehensive report of the market analysis for civil and environmental engineering graduate programs in March 2018. Hanover's report took a broad view of civil, environmental, construction and infrastructure related doctoral programs, which led to the following key conclusions:

- Job opportunities related to civil-transportation and environmental engineering in Southeast Florida are plentiful and expected to grow by 2025. Above average job growth is projected for Postsecondary Engineering Teachers, Environmental Engineers, and Civil Engineers in Workforce Regions 20 through 23. Across these key occupations, total annual job openings are expected to average 6892 – 8085.

- Combined civil-transportation and environmental engineering programs have expanded rapidly, with more than five times as many students enrolled in 2015 as in 2006. However, this is still a relatively small field, with approximately 1,200 Ph.D. enrollments nationwide in 2015. Enrollment

trends for civil and environmental engineering Ph.D. programs in Florida suggest that student demand has been steady over the past five years, with most programs enrolling between 30 and 60 students in 2017. In sum, these trends suggest that FAU's goals of enrolling 7 to 10 new students in the first year and five students per year thereafter would be feasible. However, a prospective student survey is recommended to ensure sufficient student interest. *This survey was completed and is discussed in Section II.B*.

- FAU's proposed program would be the first of its kind in Florida and among the first nationwide. At the moment, in Florida, students with a transportation or environmental engineering interest must choose between a Ph.D. in Civil Engineering (offered by six universities) or a Ph.D. in Environmental Engineering (offered by three universities). Likewise, no Florida competitors offer online or hybrid options for coursework, like FAU has proposed. FAU's closest competitors would likely be Florida International University, University of Miami, and Florida State University-FAMU, which all offer Ph.D. programs in Civil Engineering with concentrations in Environmental Engineering. A review of combined Civil-Transportation and Environmental Engineering programs nationally only identified one institution that formally offers a hybrid Ph.D. program did not reveal any similar hybrid Ph.D. program.

- FAU's proposed credit requirements are slightly lower than those of competitor programs, but its curriculum requirements are similar. FAU's proposed total credits beyond the bachelor's degree (72 credits) are slightly lower than the competitor average (76.5 credits) but similar to UCF and more than FSU/FAMU and University of Miami. Like FAU's proposal, nearly all competitor programs require a qualifying exam, dissertation proposal defense, and dissertation defense. However, unlike FAU, most competitor programs do not include a publication requirement.

The FAU Provost's office has reviewed the above findings and approved the Department's request to propose a new Ph.D. program in Transportation and Environmental Engineering.

D. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which specific goals the program will directly support and which goals the program will indirectly support (see link to the SUS Strategic Plan on the resource page for new program proposal).

This proposed program is consistent with the Florida Board of Governor's Strategic Plan (2012-2025), specifically:

Excellence: By providing a new academic program in the area of transportation engineering and environmental engineering, FAU will contribute to strengthen the quality and reputation of academic programs, scholarship, research, innovation, and community and business engagement. This new program will improve the quality and relevance of FAU's two research pillars (I-SENSE and Harbor Branch) with world-class consequential research that actively engages the community and businesses in a meaningful, measurable way. It will increase externally funded research and patents, leading to broad external recognition of our academic and research programs. Also, it will help to meet the community needs and fulfill unique institutional responsibilities by promoting the FAU mission statement of academic and personal development, discovery, and lifelong learning through excellence and innovation in teaching, outstanding research and creative activities, public engagement and distinctive scientific and cultural alliances, all within an environment that fosters inclusiveness. Furthermore, the program will address the community's acute need for transportation and environmental engineering graduates and professionals.

Productivity: By providing a new academic program in the area of transportation and environmental engineering, FAU will be increasing the degree productivity in the needed focus area of STEM in the high demand disciplines of transportation and environmental engineering. FAU will be increasing the research and commercialization activities, and increasing the level of community and business engagement. The new program will increase access and production of professional degrees in the state

of Florida, while including students from traditionally underrepresented groups, returning non-traditional students (which is a strength of FAU), and distance learning students since the program will be delivered in online and hybrid formats. The new program will also increase externally funded research and patents, while fostering a culture of entrepreneurship. Also, the proposed program will help to meet the community's need for transportation and environmental engineering graduates and professionals trained in a culture of academic and personal development, discovery, lifelong learning, and public engagement. Finally, students and faculty will engage in Florida's growing industry and the business community that is focused on mobility and the environment – both big parts of Florida's economic engine.

Strategic Priorities for a Knowledge Economy: By providing a new academic program in the area of transportation and environmental engineering, FAU will be directly increasing student access and success in degree programs in the STEM fields and other areas of strategic emphasis that respond to existing, evolving, and emerging critical needs and opportunities. Also, faculty and student researchers will be better able to attract more research funding from external sources and promote more collaboration with private industry on research projects. Finally, this new program should directly increase the number of highly trained STEM graduates who will join the transportation and environmental engineering related workforce in Florida.

STATE UNIVERSITY SYSTEM GOALS	**EXCELLENCE**	**PRODUCTIVITY**	**STRATEGIC PRIORITIES FOR A KNOWLEDGE ECONOMY**
TEACHING AND LEARNING	DIRECT Strengthen Quality and Reputation of Academic Programs and Universities	DIRECT Increase Degree Productivity and Program Efficiency	DIRECT Increase the Number of Degrees Awarded in STEM and Other Areas of Strategic Emphasis
SCHOLARSHIP, RESEARCH AND INNOVATION	DIRECT Strengthen Quality & Reputation of Scholarship, Research, and Innovation	DIRECT Increase Research and Commercialization Activity	DIRECT Increase Collaboration and External Support for Research Activity
COMMUNITY AND BUSINESS ENGAGEMENT	DIRECT Strengthen Quality & Recognition of Commitment to Community and Business Engagement	DIRECT Increase Levels of Community and Business Engagement	DIRECT Increase Community and Business Workforce

E. If the program is to be included in a category within the Programs of Strategic Emphasis as described in the SUS Strategic Plan, please indicate the category and the justification for inclusion.

The Programs of Strategic Emphasis Categories:

1. Critical Workforce:
    - Education
    - Health
    - Gap Analysis
2. Economic Development:
    - Global Competitiveness
3. **Science, Technology, Engineering and Math (STEM)**

Please see the Programs of Strategic Emphasis (PSE) methodology for additional explanations on program inclusion criteria at the resource page for new program proposal.

This proposed program is included in **Category 3. Science, Technology, Engineering, and Math (STEM)**. It is an engineering discipline (CIP code 14.9999) with emphasis on natural science, technology, engineering, mathematics, and design and construction.

F. Identify any established or planned educational sites at which the program is expected to be offered and indicate whether it will be offered only at sites other than the main campus.

The proposed program is expected to be offered at the main Boca Raton campus, with satellite research facilities and centers at the Davie campus, the Sea Tech campus, the Harbor Branch campus, and Jupiter campus with online, mostly online, and hybrid eLearning content.

II. Need and Demand

A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program which have emanated from a perceived need by agencies or industries in your service area. Cite any specific need for research and service that the program would fulfill.

The external consulting firm Hanover Research was contracted to review the demand for the program on January 22, 2018, and on August 21, 2018, they submitted the results of their market analysis ("Market Analysis," see Appendix D). Through this study, student demand was assessed as measured by degree conferral trends, the labor market outlook was measured by economic forecasts and job posting trends, and market saturation was based upon the number of graduates in the region compared to the number of projected job opportunities.

The findings by Hanover Research indicate that a combined transportation and environmental engineering program at Florida Atlantic University would be viable. Specifically, the labor market is expected to grow significantly over the next several years, and currently there are not enough graduates being produced to meet workforce demands at all levels in transportation and environmental engineering in the State of Florida. For example, the Water Research Foundation is predicting a "workforce crisis" for water utility workers as the industry will see many of its current Baby Boomer Generation employees retire between now and 2020. The recent flooding disaster in Nebraska is another poignant example. The combination of unseasonably heavy rain, melting snow from a bomb cyclone and other recent storms inundated the Midwest in early 2019, killing at least three people and causing $3 billion in damages. Rising water levels breached levees along the Missouri River and forced several towns to evacuate. Some residents were stranded for weeks as already poor roads were blocked by floodwaters and interstate highways turned into temporary rivers with more than 2,000 homes and 340 businesses lost. "The extensive flooding seen in in March 2019 will continue through May and become more dire and may be exacerbated in the coming weeks as the water flows downstream," said Ed Clark, director of NOAA's National Water Center in Tuscaloosa, AL, in a statement. "This is shaping up to be a potentially unprecedented flood season, with more than 200 million people at risk for flooding in their communities." More frequent and severe flooding will continue to grip the country, leading to more extensive rebuilding and recovery efforts that may require rethinking the whole approach to community resiliency of transportation, water resources, and environmental infrastructure. The frequency of natural disasters predicted to occur once in every 100 years are now happening every month. And these events are occurring all over the world including recent wildfires in California, the tsunami in Indonesia, hurricanes in the Caribbean and Puerto Rico, earthquakes in Alaska, tornadoes in Illinois, to name a few. These issues cannot be handled by a workforce with only BS or MS training. Long after the press coverage disappears, the task of rebuilding a more resilient human civilization requires a new paradigm that depends on a deeper understanding of how the transportation, energy, and water resources infrastructure relates to the changing environment.

According to Foley (2018) [6], the National Science Foundation's (NSF's) biennial Survey of Doctorate Recipients shows that, for the first time, private sector employment of science and engineering Ph.D.'s in the US "is now nearly on par with educational institutions." The data indicate in 2017 that private sector employment reached 42%, while educational institution hiring was 43% of the total. By comparison, educational institutions in 1997 "eclipsed private sector employment by 11 percentage points." Also according to the data specific to the "Other Engineering" category, private sector employment is 53%, while traditional civil engineering doctorates were employed only 45% in the private sector.

Recommendations:

1. FAU CEGE should move forward with marketing its program as a combined Ph.D. degree in transportation and environmental engineering, as this would be unique in Florida and in the United States.
2. FAU CEGE should position its degree as one that will prepare graduates for careers as both academic researchers and practitioners to best meet the region's workforce needs.

Key Findings

1. This proposed program would be the first of its kind in Florida and nationwide. In Florida, students must choose between a Ph.D. in Civil Engineering (offered by five SUS universities) or a Ph.D. in Environmental Engineering (offered by three SUS universities). Likewise, no Florida competitors offer online or hybrid options for coursework, such as the proposed program. Florida International University, University of Miami, and Florida State University-FAMU offer Ph.D. programs in Civil Engineering with concentrations in Environmental or Transportation Engineering, but they do not offer a combined degree. A review of combined Transportation or Environmental Engineering programs nationally did not reveal any similar hybrid Ph.D. program.

2. Enrollments in combined engineering Ph.D. programs have expanded rapidly, with nearly 7 times as many students enrolled in 2017 as in 2006 [1]. These trends suggest that students are increasingly interested in enrolling in combined engineering doctoral programs with specializations related to transportation and environmental engineering.

3. In this analysis, the number of Ph.D. candidates for student demand in transportation and environmental engineering was estimated based on the percentage of faculty in the respective areas (Transportation, Environmental, and Other) in the existing SUS civil engineering or environmental engineering Ph.D. programs (refer to Table II-5). Uncombined degree conferrals in Civil-Transportation Engineering or Environmental Engineering Ph.D. programs are higher than the national average. Specialized Ph.D. programs in Transportation/Highway Engineering doctoral degrees have increased by 6.4%, and Environmental/Environmental Health Engineering indicated 4.8% annualized growth, higher than the national average (2.8%).

4. Combined Transportation and Environmental Engineering programs would be expected to expand rapidly, with more than five times as many students enrolled in 2015 as in 2006. Enrollment trends for transportation or environmental engineering related Ph.D. programs in Florida suggest that student demand has been steady over the past five years, with most programs enrolling between 30 and 60 students in 2017. In conclusion, these trends suggest that the goal of enrolling 10 to 15 students in the first year would be feasible. However, a prospective student survey is recommended to ensure sufficient student interest and to gain further insight into student preferences in terms of delivery format. The results of the survey that was conducted in May 2018 in response to this comment were very positive. Prospective, current, and former students and potential employers indicated that 41.2% would enroll in a Ph.D. offered by the FAU Department of Civil, Environmental & Geomatics Engineering (CEGE).

5. Job opportunities related to transportation and environmental engineering in Southeast Florida are plentiful and expected to grow by 2025. Above average job growth (14.1%) is projected for Environmental Engineers and Transportation Engineers in Workforce Regions 20 through 23 from now until 2025. Across the key occupations investigated here, total annual job openings are expected to be in the range of 6892-8085, which would suggest a sizeable job market for graduates. Many of these job openings will be filled by BS and MS graduates with environmental engineering or transportation engineering backgrounds. However, those graduates will be limited in their ability to handle the increasing complexity of the competing transportation and environmental engineering issues related to sustainability and infrastructure. This is the reason for the recent surge in the demand for Ph.D. graduates not just from academia but also from government and industry [6].

6. The State of Florida is not producing sufficient numbers of transportation and environmental engineering graduates with Ph.D. level credentials to satisfy the current and future needs. The SUS transportation and environmental engineering doctoral graduates numbered only 24 in 2016. In just Workforce Regions 20-23, the labor market demand is conservatively estimated to be 6892-

8085 jobs. If the percentage of jobs requiring a Ph.D. degree across all professions (4.2%) is applied to the lower number (6892), then the demand could be estimated at 290 each year. The State of Florida produces less than 10% of the current demand for transportation and environmental engineering related Ph.D.'s, so additional programs are necessary to meet the need.

7. FAU's proposed credit requirements are slightly lower than those of competitor programs, but the curriculum requirements are similar. FAU's proposed total credits beyond the bachelor's degree (72 credits) is slightly lower than the competitor average (75.9 credits). Like FAU's proposal, nearly all competitor programs require a qualifying exam, dissertation proposal defense, and dissertation defense. However, FAU will require a publication, which is not a requirement for most competitor programs.

Outlook

The United States is facing a national challenge to rehabilitate and modernize its aging transportation and environmental infrastructure, and there is a growing demand at all levels for focused research, policy development, and engineering solutions to upgrade the nation's critical infrastructure gap, estimated at $1.5 trillion [2]. The US Congress will soon take up a $1.5 trillion infrastructure spending package, and the related employment opportunities are projected to grow by 11% annually [3]. For graduates of this program, employment opportunities in the private sector, local/state governments, public-private institutions, non-profits and non-governmental organizations in Workforce Regions 20-23 are plentiful and expected to continue to grow with annual job openings on the order of 6892-8085 [4].

State labor market projections align with occupations as defined by the Bureau of Labor Statistics' (BLS) Standard Occupational Code (SOC) system. The SOC system is analogous to the CIP system, and the two are connected by the CIP-SOC crosswalk, which maps individual (six-digit) degree programs to (six-digit) occupations (NCES 2018). This crosswalk is used to develop a list of SOC-defined occupations to assess labor market demand for individuals with training in transportation and environmental engineering. Table II-1 presents the BLS crosswalk-identified occupations related to a degree in transportation and environment engineering that typically require at least a bachelor's degree for entry into the field. Of note, the only occupations in this crosswalk that require a doctorate degree are Engineering Teachers, Postsecondary and Environmental Science Teachers, Postsecondary. However, graduate level education is still common across many of the professions listed. For example, 5.5% of Environmental Engineers hold doctorate degrees (BLS 2018). The weighted average for the SOC codes listed here is 11.9% holding doctorate degrees, compared to an average of 4.2% across all SOC occupations.

Table II-1. SOC Codes and Titles for Transportation and Environmental Engineering and Related Fields

SOC Code	SOC Title
11-1011	Chief executives
11-1021	General and operations managers
11-3071	Transportation, storage, and distribution managers
11-9021	Construction managers
11-9033	Education Administrators, Postsecondary
11-9039	Education administrators, all other
11-9041	Architectural and engineering managers
11-9121	Natural sciences managers
11-9161	Emergency management directors
11-9199	Managers, all other
17-1011	Architects, Except Landscape and Naval
17-1012	Landscape architects
17-1021	Cartographers and photogrammetrists

SOC Code	SOC Title
17-1022	Surveyors
17-2031	Biomedical Engineers
17-2041	Chemical Engineers
17-2051	Civil engineers
17-2081	Environmental engineers
17-2111	Health and safety engineers, except mining safety engineers and inspectors
17-2112	Industrial engineers
17-2121	Marine engineers and naval architects
17-2131	Materials engineers
17-2151	Mining and geological engineers, including mining safety engineers
17-2199	Engineers, all other
19-1031	Conservation scientists
19-2041	Environmental scientists & specialists, including health
19-2099	Physical scientists, all other
19-3051	Urban and regional planners
25-1031	Architecture teachers, postsecondary
25-1032	Engineering teachers, postsecondary
25-1051	Atmospheric, earth, marine, and space sciences teachers, postsecondary
25-1053	Environmental science teachers, postsecondary
25-1199	Postsecondary teachers, all other
41-9031	Sales engineers
47-2073	Operating engineers and other construction equipment operators
47-4011	Construction and building inspectors
170000	Architecture and Engineering Occupations
171000	*Architects, Surveyors, and Cartographers*
172000	*Engineers*

Statewide Market

The Florida Department of Economic Opportunity (FDEO) provides listings of employment data statewide and by workforce region. Overall, job openings for transportation and environmental engineering related occupations in Florida are summarized in Table II-2.

Table II-2. Florida Statewide Projections for Occupations Related to Transportation and Environmental Engineering, 2017-2025 (FDEO 2018)

SOC Code	Title	Employment		Projected Change		Total Job Openings
		2017	2025	Number	Percent	
11-1011	Chief executives	20,000	21,379	1,379	6.9	12,758
11-1021	General and operations managers	82,913	93,393	10,480	12.6	63,844
11-3071	Transportation, storage, and distribution managers	4,291	4,670	379	8.8	2,925
11-9021	Construction managers	31,251	34,541	3,290	10.5	20,775
11-9033	Education Administrators, Postsecondary	1,544	1,732	188	12.2	1,066
11-9039	Education administrators, all other	1,374	1,528	154	11.2	932
11-9041	Architectural and engineering managers	6,830	7,665	835	12.2	4,609
11-9121	Natural sciences managers	1,035	1,156	121	11.7	756
11-9161	Emergency management directors	155	172	17	11.0	108
11-9199	Managers, all other	43,562	47,821	4,259	9.8	28,695
17-1011	Architects, Except Landscape and Naval	6,509	7,454	945	14.5	4,806
17-1012	Landscape architects	1,954	2,215	261	13.4	1,414
17-1021	Cartographers and photogrammetrists	579	775	196	33.9	599
17-1022	Surveyors	3,718	3,946	228	6.1	2,511
17-2031	Biomedical engineers	725	897	172	23.7	571
17-2041	Chemical engineers	451	496	45	10.0	290
17-2051	Civil engineers	18,882	21,759	2,877	15.2	14,822
17-2081	Environmental engineers	2,704	3,098	394	14.6	2,089
17-2111	Health and safety engineers, except mining safety engineers and inspectors	962	1,083	121	12.6	641
17-2112	Industrial engineers	10,221	11,024	803	7.9	6,204
17-2121	Marine engineers and naval architects	299	334	35	11.7	154
17-2131	Materials engineers	588	645	57	9.7	340

SOC Code	Title	Employment		Projected Change		Total Job Openings
		2017	2025	Number	Percent	
17-2151	Mining and geological engineers, including mining safety engineers					
17-2199	Engineers, all other	5,906	6,473	567	9.6	3,682
19-1031	Conservation scientists	287	322	35	12.2	272
19-2041	Environmental scientists & specialists, including health	5,721	6,352	631	11.0	5,153
19-2042	Geoscientists, except hydrologists and geographers	626	719	93	14.9	597
19-2043	Hydrologists	253	292	39	15.4	243
19-2099	Physical scientists, all other	557	604	47	8.4	415
19-3051	Urban and regional planners	2,053	2,276	223	10.9	1,532
25-1031	Architecture teachers, postsecondary	164	185	21	12.8	130
25-1032	Engineering teachers, postsecondary	1,727	2,015	288	16.7	1,460
25-1051	Atmospheric, earth, marine, and space sciences teachers, postsecondary	412	462	50	12.1	324
25-1053	Environmental science teachers, postsecondary	112	125	13	11.6	87
25-1199	Postsecondary teachers, all other	19,411	21,909	2,498	12.9	15,439
41-9031	Sales engineers	2,037	2,261	224	11.0	1,829
47-2073	Operating engineers and other construction equipment operators	17,542	20,004	2,462	14.0	17,608
47-4011	Construction and building inspectors	7,800	8,977	1,177	15.1	7,411
170000	Architecture and Engineering Occupations	113,063	123,774	10,711	9.5	74,829
171000	*Architects, Surveyors, and Cartographers*	12,760	14,390	1,630	12.8	9,330
172000	*Engineers*	65,992	73,165	7,173	10.9	43,911
TOTAL ACROSS ALL SOC CODES		305,155	340,759	35,604	AVG = 12.7	227,091

Note: Occupational projections for SOC code 17-2151 Mining and Geological Engineers are not reported for Florida.

Based on Table II-2, employment opportunities across the SOC codes listed in the Hanover Report are projected to increase by 12.7% from 2017 to 2025 in Florida. This is slightly above the average growth rate projected for all occupations in the state during this same period (11.3%). Using the average reported percentage of Ph.D.'s employed across all occupations (4.2%), this represents 1495 new jobs from 9538 job openings for Ph.D. graduates in the state. Many of these jobs are in industry and government but also in academia where there will be future critical need to train the next generation of educators in this emerging field.

South Florida Market

FAU directly serves seven counties in southeast Florida - a densely populated region with rich geographic, economic, and social diversity and with unique infrastructure and ecological challenges. Urban development and transportation, waste management and pollution control, protection of sensitive ecosystems, Everglades restoration, utilization of limited water resources, rehabilitation and expansion of existing engineering infrastructure, and contingency planning and recovery efforts for natural disasters are examples of the tasks requiring the attention of well-educated and skilled Ph.D. level engineers. Due to the existing population, the expected growth, and the aging of much of the state's critical infrastructure, the demand for engineers in FAU's service region is above average for the State.

To estimate labor market demand in FAU's service area, FDEO database occupational projections for Workforce Regions 20 through 23, which encompass Palm Beach, Broward, Miami-Dade and Monroe, and Indian River, Martin, and Saint Lucie Counties were examined (refer to Table II-3).

According to Table II-3, in the South Florida region, transportation and environmental engineering related occupations are projected to grow at a rate of 14.1% through 2025 – slightly faster than the state growth rate (12.7%) and higher than the growth rate expected across all occupations in the state (11.3%). The FDEO projects the highest growth for cartographers and photogrammetrists (40%) and biomedical engineers, with are predicted to increase by 27.7%. Strong growth is also projected for engineering teachers, postsecondary (18.2%), environmental engineers (17.1%), civil engineers, general and other (17%). Across these SOC codes, total annual job openings are expected to average 6892 – 8085, and applying the percentage of Ph.D.'s employed across all occupations (4.2%), this corresponds to 474 new jobs from 2962 job openings over the period, which would suggest a sizeable market for graduates of FAU's proposed program. However, it is worth noting that academic job openings for engineering professors will be limited to only about 20 per year across all engineering disciplines. For this reason, FAU should position its degree as one that will prepare graduates for careers as both academic researchers but also as practitioners to best meet the region's workforce needs.

Table II-3. Southeast Florida Projections for Occupations Related to Transportation and Environmental Engineering, 2017-2025 (Workforce Regions 20-23)

SOC Code	Title	Employment		Projected Change		Total Job Openings
		2017	2025	Number	Percent	
11-1011	Chief executives	7,557	8,080	523	6.9	4,823
11-1021	General and operations managers	27,003	30,436	3,433	12.9	20,818
11-3071	Transportation, storage, and distribution managers	1,319	1,457	138	10.5	927
11-9021	Construction managers	10,696	11,813	1,117	10.8	7,099
11-9033	Education administrators, postsecondary	549	605	56	10.9	364
11-9039	Education administrators, all other	473	527	54	13.8	322
11-9041	Architectural and engineering managers	1,768	2,014	246	13.6	1,231
11-9121	Natural sciences managers	347	382	35	10.9	247
11-9161	Emergency management directors	42	46	4	9.3	29
11-9199	Managers, all other	14,806	16,138	1,332	9.6	9,606
17-1011	Architects, except landscape and naval	1,455	1,716	261	17.9	1,138
17-1012	Landscape architects	1,008	1,147	139	12.8	735
17-1021	Cartographers and photogrammetrists	75	105	30	40.0	84
17-1022	Surveyors	1,119	1,226	107	9.0	804
17-2031	Biomedical engineers	151	191	40	27.7	125
17-2041	Chemical engineers					
17-2051	Civil engineers	5,790	6,791	1,001	17.0	4,700
17-2081	Environmental engineers	747	874	127	17.1	601
17-2111	Health and safety engineers, except mining safety engineers and inspectors	260	289	29	12.3	169
17-2112	Industrial engineers	2,282	2,486	204	8.8	1,415
17-2121	Marine engineers and naval architects	15	19	4	26.7	10
17-2131	Materials engineers	73	83	10	13.6	45
17-2151	Mining and geological engineers, including mining safety engineers					
17-2199	Engineers, all other	1,045	1,198	153	13.6	717

SOC Code	Title	Employment		Projected Change		Total Job Openings
		2017	2025	Number	Percent	
19-1031	Conservation scientists	70	77	7	10.5	64
19-2041	Environmental scientists & specialists, including health(1)	1,424	1,606	182	12.9	1,318
19-2099	Physical scientists, all other	148	159	11	6.6	109
19-3051	Urban and regional planners	741	836	95	12.1	573
25-1031	Architecture teachers, postsecondary	60	65	5	8.1	45
25-1032	Engineering teachers, postsecondary	355	420	65	18.2	308
25-1051	Atmospheric, earth, marine, and space sciences teachers, postsecondary	61	70	9	14.8	50
25-1053	Environmental science teachers, postsecondary					
25-1199	Postsecondary teachers, all other	4,820	5,379	559	10.7	3,753
41-9031	Sales engineers	659	745	86	13.2	610
47-2073	Operating engineers and other construction equipment operators	4,464	5,135	671	15.3	4,544
47-4011	Construction and building inspectors	3,219	3,763	544	16.6	3,140
Total All Occupations		94,601	105,878	11,277	AVG = 14.1	70,523

Note: Occupational projections for SOC code 17-2041 Chemical Engineers, 17-2151 Mining and Geological Engineers, and 25-1053 Environmental Science Teachers, Postsecondary are not reported for all Southeast Florida counties.

The following is a partial list of the top employers for SOC codes listed in the Hanover Report. The first ten had the most job openings in the first quarter of 2018, and the remaining are in alphabetical order taken from the JobsEQ database. Some of these employers provided support letters (Appendix C) for this proposed program.

- AECOM
- State of Florida
- Stantec
- CDM Smith
- WGI
- Magic Leap
- Cyber Coders
- Kimley-Horn
- MetaOption, LLC
- HDR
- Arcadis International
- Army Corps of Engineers
- Balfour Beatty
- Bechtel Corp
- Black and Veatch
- Brown and Caldwell
- Carollo Engineers
- CH2M Hill
- DPR Construction
- FPL
- Florida Department of Transportation
- Florida Department of Environmental Protection
- Florida Department of Health
- Geosyntec Consultants
- Golder and Associates
- Hazen and Sawyer, P.A.
- Jacobs Engineering
- Kaufman Lynn Construction
- Keith and Schnars
- Lennar
- Malcolm Pirnie
- Manhattan Construction Group
- Mapei
- MasTec
- Moss and Associates
- PBS&J
- Pirtle Construction
- Radise International
- SRI Consultants
- Suffolk Construction
- Turner Construction
- Water Management Districts

The above employers have regularly hired Ph.D. graduates. Furthermore, sixteen of the eighty-

seven largest engineering design firms, all with total revenues in excess of $115 million per year, have offices in Broward and Palm Beach counties, according to the Hanover Report. Close proximity to Latin America and the widened Panama Canal and expanded southeast Florida ports provide unique opportunities for those with international interests. Thus, graduates will meet local, state, and national needs and assume positions of responsibility in academic, industrial, and government organizations.

Most transportation and environmental engineering occupations require at least a bachelor's degree for entry due to licensure requirements. However, some top employers within a 100-mile radius of FAU do require MS or Ph.D. level qualifications. For instance, a search on Indeed.com identified employers such as Kimley-Horn and Associates, Inc. requiring either an MS or Ph.D. degree for an engineering position within their Water/Wastewater and Advanced Treatment team (Indeed.com 2018).

> According to Smart Structures, "…we plan to employ some of the local Ph.D. graduates in the future."
>
> According to TranSystems, "The knowledge and skills obtained from such a Ph.D. education [Transportation and Environmental Engineering] will help to ensure the safety, security and long term viability of our community."
>
> According to the National Oceanographic and Atmospheric Administration, "As a partner, we look forward to participating in student training opportunities, mentoring, graduate committee advising, joint authorship on publications, and helping to direct this new training curriculum to help develop graduates with the technical, entrepreneurial, and executive leadership skills to address our workforce needs of the future."

Additional support letters from industry and government are found in Appendix C.

References

[1] Yoder, B. 2015. "Engineering by the Numbers." American Society for Engineering Education (ASEE). pp. 43-44. https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf

[2] American Society of Civil Engineers (ASCE). 2017. Report Card for America's Infrastructure. https://www.infrastructurereportcard.org/

[3] United States Department of Labor, Bureau of Labor Statistics, Occupational Outlook Handbook (2018).

[4] FDEO. 2018. "Employment Projections." Florida Department of Economic Opportunity (FDEO). http://www.floridajobs.org/labor-market-information/data-center/statistical-programs/employment-projections

[5] United States Department of Labor, Bureau of Labor Statistics, 2018 Educational Attainment for Workers 25 Years and Older by Detailed Occupation.

[6] Foley, D.J. (2018). Survey of Doctorate Recipients: 2017, National Center for Science and Engineering Statistics, National Science Foundation, NSF-19-301, Washington, DC.

B. Demand: Describe data that support the assumption that students will enroll in the proposed program. Include descriptions of surveys or other communications with prospective students.

Employees with Ph.D. degrees are in high demand to lead new technological advances in the transportation and environmental engineering sector in terms of research and development. The proposed Ph.D. program is focused on providing a rigorous academic education with hands-on training to prepare graduates for diverse career opportunities. The interdisciplinary nature of the proposed degree program will connect students with faculty and industry leaders in the closely related fields of engineering, science, and planning. Current research topics and trends in transportation engineering and environmental engineering, especially in the relationships between these two areas, require a set of highly specialized skills and knowledge that cannot be achieved within the breadth and duration of the training offered through traditional M.S. programs. This is because the MS level permits focus on only one of the two areas. In fact, understanding the linkages between transportation and environmental issues is one of today's greatest challenges. Graduates with a Ph.D. in transportation and environmental engineering will be needed to provide solutions such as recovery from natural disasters, developing Green infrastructure within highly developed urban corridors, increasing self-reliance on food/water/energy resources, upgrading to smart grid technologies, and adapting existing infrastructure to leverage smart technologies in mobility without adversely impacting the environment. These challenges create new roles within our society that require enormous responsibility coupled with cross-disciplinary knowledge in competing areas. Being adequately prepared with several years of advanced graduate education can lead to choices in deploying, optimizing, and improving smart infrastructure that will allow for sustainable development and community resiliency in the future.

Since 2005, records of inquiries received from potential students who wanted to pursue a doctoral degree with CEGE faculty have been kept, and the results are overwhelmingly positive. There is no sign of slowing down in terms of the demand due to the major emphasis at the federal level on infrastructure renewal and vulnerability of resiliency and mobility threats in the South Florida region. The Department receives an increasing number of inquiries from students interested to study in this field, and also from employers seeking graduates with higher degree specialization. Furthermore, interdisciplinary engineering Ph.D. programs, like the one proposed here, have expanded rapidly, with more than five times as many students enrolled in 2015 as in 2006 [1].

To assess potential student demand for a doctorate degree in transportation and environmental engineering, the enrollment and degree completion trends were examined at the national and state levels. The American Society for Engineering Education (ASEE) tracks annual enrollments in engineering disciplines for 358-member institutions (ASEE 2018). The ASEE tracks three relevant engineering disciplines at the doctoral level related to the fields of transportation and also environmental engineering: 1) environmental engineering, 2) civil engineering (with transportation specialization and environmental specialization), and 3) combined civil and environmental engineering. All three doctoral programs related to transportation and environmental engineering have demonstrated gains in enrollment over the last decade as illustrated in Figure 1. Note that enrollment reflects both full-time and part-time students. For this analysis, students enrolled in General Civil Engineering Ph.D. programs but specializing in transportation or environmental engineering are estimated using a factor of 25%, which is the typical percentage of faculty in each disciplinary area of a SUS civil engineering program (Table II-5) .

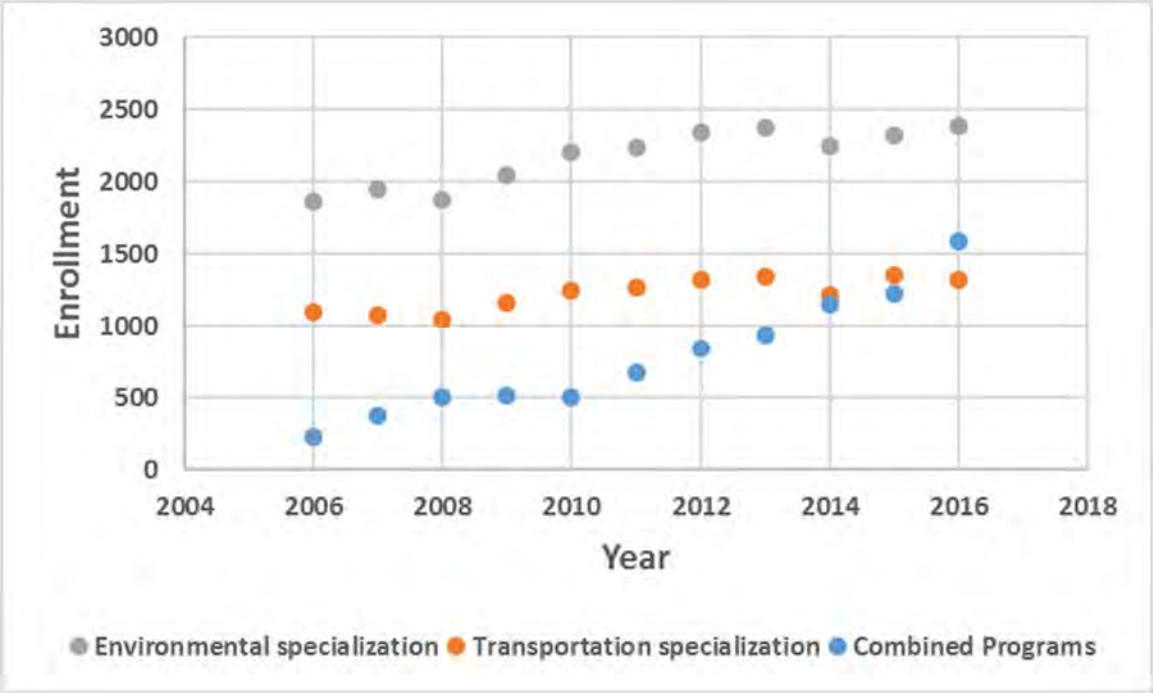


Figure 1. National Historical Headcounts in Transportation and Environmental Engineering Related Doctoral Programs, 2006-2017 (ASEE 2018)

Degree completion trends as reported by the National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS) are analyzed in terms of three metrics: 1) Compound annual growth rate (CAGR), which reflects the percentage growth that would occur each year if the same change occurred yearly between the first year and the final year; 2) Average annual change (AAC), which estimates average year-to-year differences; and 3) Standard deviation of the year-to-year change (STDEV), which indicates how significantly each year's change varies from the AAC.

Nationwide trends are summarized in Table II-4, student demand for doctoral programs in transportation and environmental engineering and related fields increased between 2012 and 2016, with an annualized growth of 6.3% [1]. This compares favorably to the annualized growth rate seen across all Ph.D. programs in the United States during this same period (2.8%) [1].

Table II-4. National Ph.D. Degree Completions in Transportation and Environmental Engineering Related Fields, 2012-2016 (IPEDS 2018)

CIP Category	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
Transportation and Highway Engineering	199	217	244	257	255	6.4%	14	12
Environmental & Environmental Health Engineering	316	368	401	419	381	4.8%	16	39
Civil Engineering, General and Other*	404	442	496	535	515	6.3%	28	33
Geological/Geophysical Engineering	4	16	18	15	21	51.4%	4	6
Surveying Engineering	2	0	0	1	9	45.6%	2	4
Total	**925**	**1,043**	**1,159**	**1,227**	**1,181**	**6.3%**	**99**	**72**

**Degree completions in the combined category (Civil Engineering, General and Other) were adjusted to determine the estimated transportation and environmental specializations using a factor of 25%.*

Table II-4 includes degree completions reported under the award level of "Doctor's degree – research/scholarship." Note that the following CIP fields reported zero completions at the doctorate level: 14.0802 Geotechnical and Geo-environmental Engineering and 14.4401 Engineering Chemistry.

In terms of statewide data, doctorate degree conferral trends for transportation or environmental engineering related fields in Florida show an annual increase of nearly 5% between 2012 and 2016 for environmental engineering, but no gains for civil engineering, general doctorate degrees. Except for the University of Florida, most competitor programs are relatively small – graduating between 2 and 13 students in 2016. However, based on these trends, FAU's short-term goal to graduate five students per year seems obtainable with the proper recruitment strategy.

In Southeast Florida specifically, the only two universities producing Ph.D. graduates in transportation or environmental engineering (and related) fields are Florida International University (FIU) and the University of Miami (UM). However, it is important to note that UM does not have a transportation specialization. An estimate of headcount and degrees awarded from Civil Engineering, General with transportation or environmental specializations was conducted by taking the percentage of the faculty in those disciplines (Table II-5).

Table II-5. Breakdown of Faculty Distribution in Florida SUS Programs

Institution	Total Faculty	ENV Faculty	TRANS Faculty	%ENV	%TRANS	%OTHER
Florida International University	30	5	7	17%	23%	60%
Florida State University/ Florida Agricultural and Mechanical University	22	4	6	18%	27%	55%
Florida Tech	25	1	4	4%	16%	80%
University of Central Florida	26	7	4	27%	15%	58%
University of Florida	64	15	7	23%	11%	66%
University of Miami	15	3	0	20%	0%	80%
University of South Florida	30	8	7	27%	23%	50%

An estimate of sub-discipline degree completions was conducted by applying faculty distribution factors from Table II-5 to the total Civil Engineering, General degree completion data. This data is summarized in Table II-6.

Table II-6. Florida SUS Doctoral Degree Completions in Transportation and Environmental Engineering Related Fields, 2012-2016 (IPEDS 2018)

Institution	**2012**	**2013**	**2014**	**2015**	**2016**	**CAGR**	**AAC**	**STDEV**
Environmental/Environmental Health Engineering								
University of Central Florida	1	3	1	5	4	41.4%	1	2
University of Florida	9	10	20	7	4	-18.4%	-1	8
University of South Florida	-	1	1	3	4	-	-	-
Total	**10**	**14**	**22**	**15**	**12**	**4.7%**	**1**	**6**
Civil Engineering, General: Environmental Specialization								
Florida International University	1	2	1	2	2	12.0%	0	1
Florida State University/ Florida Agricultural and Mechanical University	1	1	0	1	1	0.0%	0	1
Total	**2**	**3**	**1**	**3**	**3**	**10.7%**	**0**	**2**
Civil Engineering, General: Transportation Specialization								
Florida International University	2	3	2	3	3	10.7%	0	1
Florida State University/ Florida Agricultural and Mechanical University	1	1	0	2	1	0.0%	0	1
University of Central Florida	2	1	2	2	2	0.0%	0	1
University of Florida	2	2	2	2	2	0.0%	0	0
University of South Florida	1	2	1	1	1	0.0%	0	1
Total	**8**	**9**	**7**	**10**	**9**	**3.0%**	**0**	**3**

According to this data, the number of doctoral graduates from Florida SUS transportation engineering or environmental engineering related programs was 24 in 2016. Given the Ph.D. labor market demand in South Florida alone is significantly higher (refer to Table II-3), it seems that the State of Florida is not producing sufficient numbers of graduates with Ph.D. level credentials to satisfy the needs.

C. If substantially similar programs (generally at the four-digit CIP Code or 60 percent similar in core courses), either private or public exist in the state, identify the

institution(s) and geographic location(s). Summarize the outcome(s) of communication with such programs with regard to the potential impact on their enrollment and opportunities for possible collaboration (instruction and research). In Appendix C, provide data that support the need for an additional program.

The competitive landscape for FAU's proposed program is analyzed by reviewing Ph.D. programs related to transportation and environmental engineering within the State University System of Florida and private institutions in the state. The NCES database reports no doctorate degree completions (CIP code 14.9999) in transportation and environmental engineering fields within Workforce regions 20, 21, 22, and 23 between 2012 and 2016. Florida International University and the University of Miami are FAU's closest competitors geographically.

Table II-7 provides an overview of all doctorate programs related to transportation or environmental engineering identified in the State University System of Florida including the University of Miami and Florida Tech, all of which are delivered as on-site programs. Notably, FAU's proposed Ph.D. with Major in Transportation and Environmental Engineering differs from competitors in that no other Florida university offers a combined Ph.D. in transportation and environmental engineering. Likewise, no Florida competitors offer fully online or hybrid options for coursework, as FAU has proposed. However, two competitors in the SUS (Florida International University and FAMU/Florida State University) do offer Ph.D. programs in Civil Engineering with separate concentrations in Transportation Engineering or Environmental Engineering. These concentration areas are described as *research specialties*, although they are typically not associated with required core coursework. Offering a combined degree program would, therefore, distinguish FAU from the rest of the current programs in the State University System of Florida.

IPEDS (2018) reports the past five years of distance education program completions, which rely on "*one or more technologies to deliver instruction to students who are separated from the instructor*." However, programs classified as distance education are not necessarily fully online and may involve residential requirements. Additionally, because IPEDS does not disaggregate distance and onsite completions by the institution, there is no way to determine the number of distance completions within a given academic field, only the number of institutions that report offering a distance program.

Table II-7. Overview of Doctorate Programs Related to Transportation and Environmental Engineering in the State University System of Florida (NCES 2018)

Institution	Program	Concentrations
Florida International University	PhD in Civil Engineering	Structural Construction and Geotechnical, *Environmental* and Water Resources, *Transportation*
University of Florida	PhD in Civil Engineering	Coastal & Oceanographic, Coastal Ecosystem Dynamics, Geosystems, Materials & Pavements, Public Works, Structural, Sustainable Construction, Water Systems, *Transportation*
	PhD in Environmental Engineering	Air Resources, Coastal Ecosystems, Environmental Nanotechnology, Systems Ecology
University of Central Florida	PhD in Civil Engineering	Geotechnical, Structural, Water Resources, Construction Management, *Transportation Systems*
	PhD in Environmental Engineering	Water Process, Waste Treatment, Air Quality
University of South Florida	PhD in Civil Engineering	International Development, Geotechnical, Materials Science, Structures, *Transportation*, Water Resources
	PhD in Environmental Engineering	--
Florida State University-FAMU*	PhD in Civil Engineering	Structures, Construction, Water Resources, Geotechnical, *Environmental*, *Transportation*
Florida Tech**	PhD in Civil Engineering	Construction Management, Geotechnical, Structural, Water Resources, *Environmental, Transportation*
University of Miami***	PhD in Civil Engineering	Civil, Architectural, or Environmental Engineering

**Joint program between Florida State University and Florida Agricultural and Mechanical University.*
***Private institution not in the State University System of Florida.*

As shown in Table II-8, there are very few universities in the United States that offer distance learning options for doctorate degrees in fields related to transportation and environmental engineering. Those that offer some distance learning coursework are very small programs. One such institution is the University of South Carolina – Columbia (Ph.D. in Civil Engineering, General). The College of Engineering and Computing "offers certain online courses for busy professionals seeking advanced degrees...Students in the program view their classes via streaming video" with "various courses offered three times a year following a tri-semester plan." While their Ph.D. in Civil Engineering, General is not specifically marketed as a hybrid program, students may take advantage of the online coursework. However, all doctoral-level programs require "a research component that must be done in residence."

Table II-8. Degrees Awarded at Institutions offering Distance Learning Options in Fields Related to Transportation and Environmental Engineering, 2012-2016 (IPEDS 2018)

Institution	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
Civil Engineering, General								
Columbia University in the City of New York	7	13	7	9	10	9.3%	1	4
University of Alabama Huntsville	-	-	-	2	2	-	-	-
University of South Carolina - Columbia	6	6	11	9	4	-9.6%	-1	4
Total	**13**	**19**	**18**	**20**	**16**	**5.3%**	**1**	**6**
Environmental/Environmental Health Engineering								
Columbia University in the City of New York	4	4	-	-	-	-	-	-
Total	**4**	**4**	**-**	**-**	**-**	**-**	**-**	**-**

A complete listing of combined engineering Ph.D. programs can be found on the ASEE's Alphabetical List of Participating Graduate Degree Programs (ASEE 2018). Nationally, this list identifies no universities that offer combined transportation and environmental engineering Ph.D. programs, similar to what FAU has proposed. There are some programs that offer both transportation engineering and environmental engineering topics as core coursework, rather than as concentrations, such as The University of South Carolina's Ph.D. in Civil Engineering, General.

Transportation engineering and environmental engineering related university department websites for 30 institutions were reviewed, including those listed by the ASEE, to determine if any offer hybrid or online Ph.D. programs that were not captured by IPEDS data. One such program (combined Ph.D. in Civil and Environmental Engineering) was identified at Clarkson University, which offers an "off campus" Ph.D. option for students in 12 different fields of study, including Civil & Environmental Engineering. The off campus option is designed for working professionals when their "Ph.D. research directly aligns with research needs of [their] employer." In collaboration with research advisors from Clarkson, students work with a co-advisor at their place of employment to develop a research project that meets the requirements of the Ph.D. program. Employers must also meet Clarkson's conflict of interest policy requirements. Students can transfer up to 30 credits towards the 90 credit coursework requirement and also complete up to 9 credits through online courses. Each department specifies the period the student spends on campus (at the department) and the number of visits (each semester).

Two of the other institutions reviewed (Stanford University and the University of Illinois) offer combined master's degrees (in civil and environmental engineering) online, but not doctoral degrees. Given the scarcity of existing online and hybrid Ph.D. programs in many engineering disciplines, Ph.D. programs within the separate fields of transportation engineering or environmental engineering were also reviewed, and six were identified with hybrid options:

- Auburn University (Ph.D. in Civil Engineering) offers hybrid coursework with department approval
- Columbia University (Ph.D. in Earth and Environmental Engineering) offers partially online courses
- Illinois Institute of Technology (Ph.D. in Civil Engineering and Ph.D. in Environmental Engineering) states in the catalog that online courses are available on a case by case basis
- Mississippi State University (Ph.D. in Civil Engineering) offers hybrid coursework, but no degree completions were reported in 2017

- University of Alabama-Huntsville (Ph.D. in Civil Engineering) offers coursework through a primarily online format
- University of South Carolina-Columbia (Ph.D. in Civil Engineering) has advertised a hybrid format on their website..

Even within the broad fields of transportation engineering and environmental engineering (as well as combined civil engineering programs), offering formal online or hybrid Ph.D. programs appears to be rare. Some institutions may offer a master's degree and/or individual courses online, which may make it possible for students to complete some of their Ph.D. degree coursework requirements off-campus. However, such Ph.D. programs are rarely marketed specifically as a hybrid program. Among existing competitors, the typical target audience is full-time onsite students who are interested in conducting research.

To complement NCES degree completions trends, the Florida State University System Board of Governors also publishes enrollment data, which provides a more up to date snapshot of student demand in the state. Remarkably, enrollment in FAMU/FSU's Ph.D. in Civil Engineering program has almost tripled over the past five years. However, FAU's closest competitor, FIU, has seen an enrollment decrease since 2013. These trends suggest student demand varies from year to year and program to program. The same can be said of the three environmental engineering Ph.D. programs in the state. USF's program, for instance, has doubled enrollments over the past five years. While UCF and UF have remained relatively flat. However, across the entire SUS, Ph.D. enrollments have remained steady over the past five years for programs related to transportation or environmental engineering, suggesting student demand is consistent.

In terms of enrollment volume, all universities except for University of Miami, enrolled at least 33 students in their Ph.D. programs in 2017 across all transportation and environmental engineering related doctoral programs. Assuming students are completing these programs within four to six years, this confirms that FAU's goals of enrolling 7 to 10 students in the first year and graduating 5 or more students per year after the first six years are reasonable. Applying the same methodology previously used in the Student Demand section, Table II-9 shows that the headcounts statewide are generally increasing.

Table II-9. Florida SUS Doctoral Degree Estimated Headcounts in Transportation and Environmental Engineering Related Fields, 2012-2016 (SUS Board of Governors 2018, UM 2018, Florida Tech 2018)

Institution	2012	2013	2014	2015	2016	CAGR
Environmental/Environmental Health Engineering						
University of Central Florida	13	17	15	10	12	-2.0%
University of Florida	52	47	45	49	42	-5.2%
University of South Florida	12	16	15	20	25	20.1%
Total	**77**	**80**	**75**	**79**	**79**	**+0.6%**
Civil Engineering, General: Environmental Specialization						
Florida International University	11	12	10	9	8	-7.7%
Florida State University/ Florida Agricultural and Mechanical University	2	3	4	4	6	31.6%
University of Miami*	3	3	3	3	3	0.0%
Total	**16**	**18**	**18**	**16**	**17**	**+1.5%**
Civil Engineering, General: Transportation Specialization						
Florida International University	16	17	15	13	11	-8.9%
Florida State University/ Florida Agricultural and Mechanical University	4	5	6	7	9	22.5%
University of Central Florida	8	10	10	10	12	10.7%
University of Florida	7	7	7	7	7	0.0%
University of South Florida	13	11	10	11	12	-2.0%
Florida Tech*	1	2	2	2	1	0.0%
Total	**49**	**52**	**50**	**50**	**52**	**+1.5%**

*Private institution not in the Florida SUS

D. Use Table 1 in Appendix A (1-A for undergraduate and 1-B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources. Generally undergraduate FTE will be calculated as 30 credit hours per year and graduate FTE will be calculated as 24 credit hours per year. Describe the rationale underlying enrollment projections. If students within the institution are expected to change majors to enroll in the proposed program at its inception, describe the shifts from disciplines that will likely occur.

The headcount given in Table 1-B in Appendix A was estimated based on the current Ph.D. students supervised by the CEGE faculty and inquiries of the Ph.D. program for the last five years. Currently, 12 students enrolled in the Ocean Engineering (OE) Ph.D. program are under the supervision of CEGE faculty members. Seven (7) are expected to switch at the inception of the proposed Ph.D. program in Fall 2020. From that group, three are from industry.

The environmental/water resources group in the Department will receive a multi-year $3 million grant from FEMA to investigate statewide flooding master planning, which will require 3 doctoral students and 2 post-docs for the initial 3-year planning study. The urban mobility and sustainable infrastructure group in the Department has recently received large-scale funding as part of the Tier 1 Transportation Center, and is expected to require 4 doctoral students as part of multi-year projects. Based on prospective student interest, it is estimated that 2-3 Ph.D. students will come from local industry, 2-3 from graduates of the Master of Science in Civil Engineering program, and 3-4 recruited from foreign countries. In 2017-2018, CEGE faculty were responsible

for securing $2.6 million, and in 2018-March 2019, an additional $5.1 million is secured. In addition, two new faculty hires (one transportation engineering and one environmental engineering) are being added to the Department with external searches being completed in Spring 2019. It is anticipated that both of these new hires will use startup funds to bring doctoral students (not counted in the estimate). Thus the proposed degree program is projected to have a headcount that should be able to graduate 3-5 Ph.D. students each year after year 5.

Out of 12 Ph.D. students currently registered for the OE Ph.D. program, 7 would have switched to the proposed Ph.D. program if it started today. The remaining 5 in the structural and geotechnical engineering area will stay in the OE Ph.D. program. Therefore, the impact of the Ph.D. in transportation and environmental engineering on the OE Ph.D. program is minimal because CEGE will continue recruiting Ph.D. students in structural engineering and geotechnical engineering for the sustainable infrastructure track in the Ph.D. with Major in Ocean Engineering. Even without those students, the OE Ph.D. program is self-sustaining, as the number of graduates has surpassed the state requirement of 15 over a 5-year period.

E. Indicate what steps will be taken to achieve a diverse student body in this program. If the proposed program substantially duplicates a program at FAMU or FIU, provide, (in consultation with the affected university), an analysis of how the program might have an impact upon that university's ability to attract students of races different from that which is predominant on their campus in the subject program. <u>The university's Equal Opportunity Officer shall review this section of the proposal and then sign and date Appendix B to indicate that the analysis required by this subsection has been completed</u>.

The FAU College of Engineering and Computer Science has been very successful in achieving diversity in its student body. We typically rank high nationally in numbers of B.S. degrees awarded to African Americans and Hispanics. The College is a major player in SECME, Inc. (Southeastern Consortium for Minorities in Engineering). FAU is recognized for providing more SECME scholarships (25) than any other participating university, and for its outstanding university-industry SECME partnership. The FAU-Palm Beach County program is considered a role model for the entire SECME organization. With its broad input from the community, business and industry, SECME has contributed much to student diversity in the College.

The Division of Student Services within the College of Engineering and Computer Science has an outstanding record of supporting student success and professional development. The Division is a major factor in the numbers of women and minorities who successfully complete their degree programs at FAU and who go on to positions of leadership in their communities and in their professions. In a recent FAU survey of student satisfaction with advising and support services, the College of Engineering and Computer Science ranked first among the colleges of the University. Efforts to promote diversity are on-going. The diversity of the southeast Florida region is expected to achieve levels that will not have an ethnic or racial majority in the near future. The FAU student body in general is expected to continue to reflect the diversity of the region. Indeed, FAU was recently pronounced to be the most diverse university in the public university system of Florida. It was also designated as a Hispanic Serving Institution by the US Department of Education. The current undergraduate and graduate degree programs in the College of Engineering and Computer Science reflect that diversity. It is, therefore, reasonable to believe that this new proposed program will also reflect the diversity of the university. The Ph.D. program in Transportation and Environmental Engineering will target groups that are under-represented in engineering.

The proposed program will make recruitment of such students a high priority in its recruitment plan. In particular, universities and colleges in the State of Florida and throughout the nation will be targeted for student recruitment through brochures and other recruitment efforts. Additionally, faculty recruitment will emphasize identification of qualified minority candidates which in turn will attract minority students through identification with faculty as potential role models and mentors. As of the Spring 2019 semester, the CEGE Department diversity of graduate students is as follows with 46% female (Figure 2):

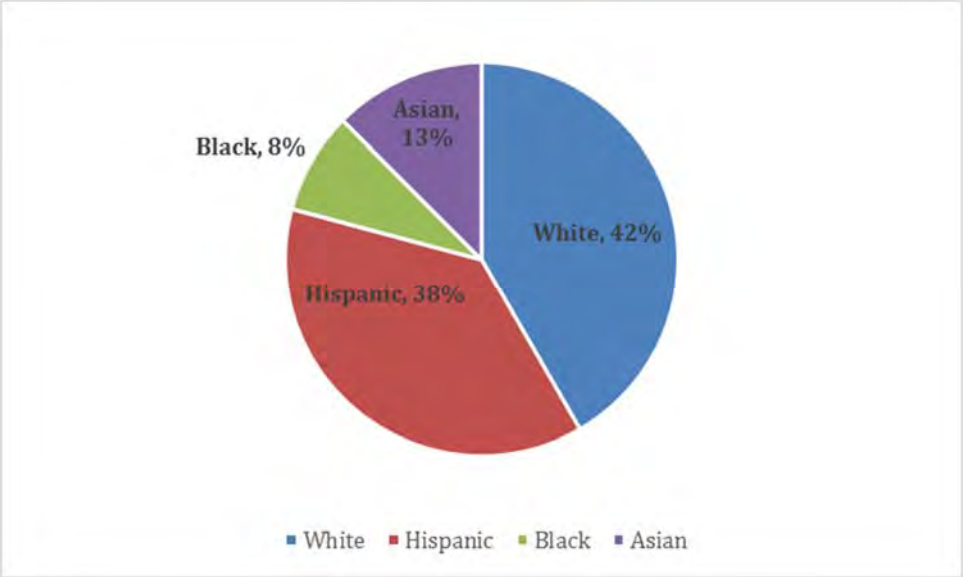


Figure 2. CEGE Department graduate program diversity chart.

III. Budget

A. Use Table 2 in Appendix A to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 in Appendix A to show how existing Education & General funds will be shifted to support the new program in Year 1. In narrative form, summarize the contents of both tables, identifying the source of both current and new resources to be devoted to the proposed program. (Data for Year 1 and Year 5 reflect snapshots in time rather than cumulative costs.)

With the recent faculty hires in environmental and transportation engineering for the 2019-2020 academic year, faculty staffing in the Department is sufficient to initiate the program. The faculty salary and benefits needed to support this program will come entirely from reallocated base E&G funds. For Year 1, the budget includes $225,916 in funds reallocated from the Department to fund faculty salaries and benefits for the current faculty members in the program, and the recent new faculty members being hired on vacant lines. The reallocated salaries and benefits extend into the fifth year and include any increases in percent effort for current faculty as well as salaries and benefits for two new faculty members (one starting in Fall 2021 and one starting in Fall 2023), for a total of $516,370 for Year 5. See Table 4 (Appendix A) for a complete listing of faculty involved with the program.

Reallocated base funding is also being used to support one AMP student coordinator position at 25% effort in Year 1 ($19,635) and 45% effort by Year 5 ($35,342) to this program based on the anticipated growth in student enrollment.

The Department currently supports 14 graduate assistantships for full-time students. It has a history of supporting graduate research assistantships (GRA) through research contracts and grants. As stated in Section I-D, in 2017-2018, CEGE faculty were responsible for securing $2.6 million, and in 2018-March 2019, an additional $5.1 million is secured. Furthermore, two new faculty hires (one transportation engineering and one environmental engineering) are being added to the Department with external searches being completed in Spring 2019. Funding for four additional GRA positions would come from sponsored research and startup funding for new faculty in Year 1 ($68,000). In 2019, CEGE faculty are recruiting 7 GRA positions with sponsored research funds. By Year 5, ten more GRA positions compared to the current level will be supported by sponsored research based on the projected full-time enrollment ($170,000).

Expenses in Table 2 include computers/printers, copier, phones, postage, printing, travel, office supplies, information technology supplies, and specialized software. An allocation for recruiting (brochures, travel, etc.) is also requested to be able to attract new students from outside agencies and industry in our service areas. This proposed program is a priority for the College such that funding will be reallocated to match the university/College priorities. There are minimal impacts to existing programs from this reallocated amount because GRA support comes from pending and existing research grants and faculty will devote time for dissertation supervision not additional teaching loads.

B. Please explain whether the university intends to operate the program through continuing education, seek approval for market tuition rate, or establish a differentiated graduate-level tuition. Provide a rationale for doing so and a timeline for seeking Board of Governors' approval, if appropriate. Please include the expected rate of tuition that the university plans to charge for this program and use this amount when calculating cost entries in Table 2.

NOT APPLICABLE.

C. If other programs will be impacted by a reallocation of resources for the proposed program, identify the impacted programs and provide a justification for reallocating resources. Specifically address the potential negative impacts that implementation of the proposed program will have on related undergraduate programs (i.e., shift in faculty effort, reallocation of instructional resources, reduced enrollment rates, greater use of adjunct faculty and teaching assistants). Explain what steps will be taken to mitigate any such impacts. Also, discuss the potential positive impacts that the proposed program might have on related undergraduate programs (i.e., increased undergraduate research opportunities, improved quality of instruction associated with cutting-edge research, improved labs and library resources).

The impact of the reallocation of resources for the proposed program to the existing BS and MS programs will be minimal for the first five years. First, the current faculty are delivering BS and MS programs and supervising 13 students enrolled in the Ocean Engineering Ph.D. program simultaneously. Second, the 0.69 PY FTE for the first year will be offset by the two new faculty hires in Fall 2019. Similarly, the 1.44 PY FTE for the fifth year will be offset by another two new hires in Fall 2021 and Fall 2023, respectively.

D. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside of the proposed major).

Several CEGE faculty are supervising 12 students currently enrolled in the Ph.D. with Major in Ocean Engineering (OE) as part of the Sustainable Infrastructure track. Once the proposed Ph.D. program is established, we anticipate that up to seven (7) of those students will most likely transfer to the new degree program, which will cause a temporary setback to the OE program. However, this foreseeable, short-term setback will not adversely affect this program to meet the BOG requirement of 15 graduates within five years because they already have healthy student enrollments, and we anticipate that about half of the doctoral students supervised by CEGE faculty are in the field of structural engineering or geotechnical engineering, who would be more suited to the OE Ph.D. program. Therefore, CEGE will continue to support the OE Ph.D. program with a pipeline of structural and geotechnical engineering focused candidates.

E. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). Describe the external resources that appear to be available to support the proposed program.

Because of the very pressing demand for trained engineering professionals in Florida, the proposed program is attracting generous offers of help and financial support in the forms of donations from business and industry, private contributions, and contributions in-kind. Once the degree has been approved by the BOT, an extensive program of development and fundraising for support will be implemented by the College's Director of Development and the College's Executive Advisory Board. Conversations with professional societies and with business and industry show very strong interest in in-kind gifts. Possibilities include use of equipment and/or facilities; provision of speakers, instructors, and mentors; the contribution of real-world design problems; etc. Donations, research contracts, grants, and in-kind gifts supportive of the program are expected. These funds are listed in Appendix A-Table 4 under Contracts & Grants.

IV. Projected Benefit of the Program to the University, Local Community, and State

Use information from Tables 1 and 2 in Appendix A, and the supporting narrative for "Need and Demand" to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. The projected benefits can be both quantitative and qualitative in nature, but there needs to be a clear distinction made between the two in the narrative.

Quantitative

If the proposed Ph.D. program is implemented, the research active CEGE faculty will grow from 35% to 75% and corresponding average annual research expenditures will increase from $1.1 million to $2.4 million within the next five years. Another Department strategic goal is to leverage these funds to attract one new State or federally funded center of excellence. The corresponding scholarly work products (books, monographs, and other peer-reviewed publications) will increase to more than 100 per year to promote the international reputation of the Department's world-class faculty.

According to the Hanover Research market analysis, job opportunities related to transportation and environmental engineering in Southeast Florida are plentiful and expected to grow by 2025. Above average job growth (14.1%) is projected for Transportation Engineers and Environmental Engineers in Workforce Regions 20 through 23 from now until 2025. Across the key related occupation codes, total annual job openings are expected to be in the range of 6900-8100 in Southeast Florida alone, which would suggest a sizeable job market for graduates of FAU's proposed program. This workforce will provide solutions to long term economic viability and environmental sustainability of the south Florida community, the state of Florida, and beyond.

For a one-month period taken from February 15, 2018 to March 15, 2018, there were 409 job openings in Workforce Regions 20-23 in just the top 15 transportation and environmental engineering related occupations (FDEO, 2017). In 2016, the estimated output of SUS transportation and environmental engineering related doctoral programs produced only 24 degree completions, some of which may not remain in Florida. If a new FAU degree program can add another 15-20 graduates that take locally available jobs, this would mean an addition of $1.5 million dollars to the local economy based on a weighted average of the 2017 median hourly salaries for the list of transportation and environmental engineering related occupation codes working 40 hours per week, 52 weeks per year, equivalent to $96,550 for the Florida job market and $96,620 for the South Florida market (BLS 2018).

In the Hanover Report, it is stated that, "*enrollments in combined engineering Ph.D. programs have expanded rapidly, with nearly seven times as many students enrolled in 2017 as in 2006 (Yoder 2017).*" These trends suggest that students are increasingly interested in enrolling in combined engineering doctoral programs with specializations related to transportation and environmental engineering. Uncombined degree conferrals in Transportation Engineering and also Environmental Engineering Ph.D. programs are higher than the national average. Transportation and Highway Engineering doctoral degrees have increased by 6.4%, and Environmental/Environmental Health Engineering indicated 4.8% annualized growth, higher than the national average (2.8%).

Qualitative

The labor market outlook for transportation and environmental engineering-related occupations is strong. The Florida Department of Economic Opportunity (FDEO) forecasts economic growth of around 16% in South Florida through 2022 for these fields. Institutions in Florida are not currently

producing enough graduates to meet the labor market demand for the local environmental engineering workforce. SUS schools produced only 24 graduates in transportation and environmental engineering related programs in 2016, while the FDEO projects 6900-8100 annual job openings in related positions in Workforce Region 20-23. If the percentage of jobs requiring a Ph.D. degree across all professions (4.2%) is applied, then the demand could be estimated at 290-340 each year. Thus, the SUS is fulfilling less than 10% of the annual workforce needs in these critical fields for future growth.

This focused Ph.D. program will help to attract top students, enhance faculty scholarship productivity, expand external research funding, increase private and public participation from community partners, and make great strides toward achieving research and academic excellence to increase the pre-eminence and ranking of Florida's State University System. The aim is to produce a high-quality workforce that is ready to step in directly to industry, government, and academia and contribute to Florida's future growth.

V. Access and Articulation – Bachelor's Degrees Only

A. If the total number of credit hours to earn a degree exceeds 120, provide a justification for an exception to the policy of a 120 maximum and submit a separate request to the Board of Governors for an exception along with notification of the program's approval. (See criteria in Board of Governors Regulation 6C-8.014)

NOT APPLICABLE.

B. List program prerequisites and provide assurance that they are the same as the approved common prerequisites for other such degree programs within the SUS (see link to the Common Prerequisite Manual on the resource page for new program proposal). The courses in the Common Prerequisite Counseling Manual are intended to be those that are required of both native and transfer students prior to entrance to the major program, not simply lower-level courses that are required prior to graduation. The common prerequisites and substitute courses are mandatory for all institution programs listed, and must be approved by the Articulation Coordinating Committee (ACC). This requirement includes those programs designated as "limited access."

If the proposed prerequisites are not listed in the Manual, provide a rationale for a request for exception to the policy of common prerequisites. NOTE: Typically, all lower-division courses required for admission into the major will be considered prerequisites. The curriculum can require lower-division courses that are not prerequisites for admission into the major, as long as those courses are built into the curriculum for the upper-level 60 credit hours. If there are already common prerequisites for other degree programs with the same proposed CIP, every effort must be made to utilize the previously approved prerequisites instead of recommending an additional "track" of prerequisites for that CIP. Additional tracks may not be approved by the ACC, thereby holding up the full approval of the degree program. Programs will not be entered into the State University System Inventory until any exceptions to the approved common prerequisites are approved by the ACC.

NOT APPLICABLE.

C. If the university intends to seek formal Limited Access status for the proposed program, provide a rationale that includes an analysis of diversity issues with respect to such a designation. Explain how the university will ensure that Florida College System transfer students are not disadvantaged by the Limited Access status. NOTE: The policy and criteria for Limited Access are identified in Board of Governors Regulation 6C-8.013. Submit the Limited Access Program Request form along with this document.

NOT APPLICABLE.

D. If the proposed program is an AS-to-BS capstone, ensure that it adheres to the guidelines approved by the Articulation Coordinating Committee for such programs, as set forth in Rule 6A-10.024 (see link to the Statewide Articulation Manual on the resource page for new program proposal). List the prerequisites, if any, including the specific AS degrees which may transfer into the program.

NOT APPLICABLE.

INSTITUTIONAL READINESS

VI. Related Institutional Mission and Strength

A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan (see link to the SUS Strategic Plan on the resource page for new program proposal).

This proposed program is consistent with the Florida Board of Governor's Strategic Plan (2012-2025), specifically:

Excellence: By providing a new academic program in the area of transportation engineering and environmental engineering, FAU will be helping to strengthen the quality and reputation of academic programs, scholarship, research, innovation, and community and business engagement. This unique Ph.D. will grow the number of Florida's new academic programs with state, national and international preeminence. will improve the quality and relevance of FAU's two research pillars (I-SENSE and Harbor Branch) with world class consequential research that actively engages the community and businesses in a meaningful, measurable way. It will increase externally funded research and patents, leading to broad external recognition of our academic and research programs. Also, it will help to meet the community needs and fulfill unique institutional responsibilities by promoting the FAU mission statement of academic and personal development, discovery, and lifelong learning through excellence and innovation in teaching, outstanding research and creative activities, public engagement and distinctive scientific and cultural alliances, all within an environment that fosters inclusiveness. Furthermore, the program will address the community's acute need for transportation and environmental engineering graduates and professionals. The goal will be to attract more high profile research centers like the Tier 1 Department of Transportation (FMRI Institute) to grow the number of centers and institutes recognized nationally for scholarship, research, and commercialization.

Productivity: By providing a new academic program in the area of transportation and environmental engineering, we will be increasing the degree productivity in the needed focus area of STEM in the high demand disciplines of transportation and environmental engineering. FAU will be increasing the research and commercialization activities, and increasing the level of community and business engagement. The new program will increase access and production of professional degrees in the state of Florida, while including students from traditionally underrepresented groups, returning non-traditional students (which is a strength of FAU), and distance learning students, (100% of coursework is available in distance learning format). Most particularly because the program will be delivered in online and hybrid formats. The new program will also increase externally funded research and patents, while fostering a culture of entrepreneurship. Also, the proposed program will help to meet the community's need for transportation and environmental engineering graduates and professionals trained in a culture of academic and personal development, discovery, lifelong learning, and public engagement. Finally, students and faculty will engage in Florida's growing industry and the business community that is focused on mobility and the environment – both big parts of Florida's economic engine.

Strategic Priorities for a Knowledge Economy: By providing a new academic program in the area of transportation and environmental engineering, FAU will be directly increasing student access and success in degree programs in the STEM fields and other areas of strategic emphasis that respond to existing, evolving, and emerging critical needs and opportunities. In addition, faculty and student researchers will be better able to attract more research funding from external sources and promote more collaboration with private industry on research projects. Finally, this new program

should directly increase the number of highly trained STEM graduates who are employed in Florida, in which a large number of transportation and environmental engineering related jobs remain available. The innovative graduate internship with the collaboration of external members of the dissertation/supervisory committee will improve graduate's career skills needed to succeed in the workplace and increase the percentage of graduates who are employed in Florida.

FAU Institutional Goals

Goal 1: *Access to and production of degrees*.
By providing a new academic program in the area of transportation and environmental engineering, FAU will be increasing access to and production of professional degrees in the State of Florida.

Goal 2: *Meeting statewide professional and workforce needs*.
By providing a new academic program in the area of transportation and environmental engineering, FAU will be helping to meet critical needs in STEM fields that deal with the priorities of transportation mobility issues and infrastructure design and construction of the natural and the built environment. In addition, the mere fact that Florida is prone to natural disasters such as flooding, droughts, hurricanes, and wildfires that impact tourism, mobility, and sustainability creates a special need for doctoral graduates in transportation and environmental engineering.

Goal 3: *Building world-class academic programs and research capacity*.
By providing a new academic program in the area of transportation and environmental engineering, FAU will be helping to increase externally funded research and patents while broadening external recognition of our academic and research programs. Notably, faculty and students affiliated with the Department won the 2012 National Council of Examiners for Engineering and Surveying (NCEES) Award ($25,000 Grand Prize Winner) for faculty/student participation in the design of the City of Dania Nanofiltration Facility that is the first water treatment plant to receive a LEED Gold certification in the world. The proposed program will create new opportunities for engineering collaboration with science and urban/regional planning.

Goal 4: *Meeting community needs and fulfilling unique institutional responsibilities*.
By providing a new academic program in the area of transportation and environmental engineering, FAU will support its institutional mission statement of promoting academic and personal development, discovery, and lifelong learning through excellence and innovation in teaching, outstanding research and creative activities, public engagement and distinctive scientific and cultural alliances, all within an environment that fosters inclusiveness. Furthermore, the program will address the community's acute need for transportation and environmental engineering graduates and professionals.

FAU's current Strategic Plan created a system of pillars and platforms to catapult the university to become the fastest growing in the country in its bid to move FAU toward national prominence. Two of the pillars of the university are directly aligned to this proposed doctoral degree program. I-SENSE, which is the Institute for Sensing and Embedded Network Systems Engineering that supports advancements in computing and sensing technologies targeted toward infrastructure systems, marine and environmental systems, and health/behavior. The other pillar is the Harbor Branch Oceanographic Institute for ocean science and engineering/environmental sciences research effort. The Department created two strategic focus groups for strengthening emerging research: 1) urban mobility and 2) environmental sustainability. This proposed program will be a perfect addition to those pillars.

The current FAU Strategic Plan also lists a set of 6 goals in which our proposed academic program in transportation and environmental engineering can help the University build on existing strengths in the following ways:

1. Boldness: Build a geographically-diverse population of students who excel in focused academic areas and engage in enriching activities that drive them to timely graduation at FAU. This program will contribute to the two pillars of I-SENSE and ocean science and engineering/environmental sciences as well as providing timely graduation by offering an engineering doctoral degree with 72 credits as opposed to 90-96.
2. Synergy: Connect the most talented faculty, staff, and students via the pillars and platforms. This program will contribute to the two main pillars of I-SENSE and ocean science and engineering/environmental sciences as well as providing opportunities for doctoral students to mentor undergraduate research and inquiry while engaging with the community.
3. Place: Deep engagement with South Florida's global communities
4. Quality: Continuously assessed programs. The proposed program will be offered with SAC's continuous improvement model for excellence and will be run with a resilient, lean organizational structure that capitalizes on existing world class faculty and staff.
5. Brand: A world-class undergraduate program in environmental engineering will communicate FAU's excellence and key internal stakeholders to a global audience of external constituency groups.
6. Strategy: This new program will allow FAU to become more competitive for public and private funding opportunities.

B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.

FAU has strategic pillars that are institutional activities that create new knowledge to benefit society. Two of the pillars of the university are directly aligned to this proposed doctoral degree program. I-SENSE, which is the Institute for Sensing and Embedded Network Systems Engineering that supports advancements in computing and sensing technologies targeted toward infrastructure systems, marine and environmental systems, and health/behavior. The other pillar is the Harbor Branch Oceanographic Institute for ocean science and engineering/environmental sciences research effort.

The proposed program also relates to the following university platforms:

1. Big Data Analytics (supporting the development of tools to mine large datasets)
2. Community Engagement and Economic Development (supporting work with communities to develop solutions to address engineering challenges and economic prosperity)
3. Diversity (transportation and environmental engineering typically has a larger percentage of women and minority students enrolled compared to the other engineering disciplines)
4. Global Perspectives and Participation (supporting opportunities to share technology and discoveries with other institutions around the globe)
5. Healthy and Environmentally Sustainable Campus (supporting opportunities to incorporate scholarship into campus operations)
6. Leadership, Innovation, and Entrepreneurship (supporting engagement of faculty and students in the professional development of leadership, intellectual property, and creation of startup companies)
7. Peace, Justice, and Human Rights (supporting programs that share best practices and

promote tolerance particular with respect to environmental justice)

8. Undergraduate Research and Inquiry (supporting opportunities for Ph.D. students to mentor undergraduate students)

The Department created two strategic focus groups for strengthening emerging research: 1) urban mobility and 2) environmental sustainability. CEGE faculty are responsible for $2.6 million external research funding (FY2017-18), providing a solid base for student support, and the proposed doctoral program will provide significant leverage to help double research expenditures by bringing more national/state research centers like our Tier 1 University Transportation Center supported by USDOT, as well as our other research labs and centers: Freight Mobility Research Institute (FMRI), Laboratory for Adaptive Traffic Operations and Management (LATOM) at the Transportation Engineering Research Hub, Hydrosystems Research Laboratory (HRL), and the Laboratories for Engineered Environmental Solutions (Lab.EES).

Specific institutes and centers with a high degree of potential collaboration include:

- The Adams Center for Entrepreneurship in the College of Business. The center works with FAU faculty and students with entrepreneurship interests and assists them with conducting and publishing significant research (Director Kimberly Gramm)
- The Florida Center for Environmental Studies. The center serves as a facilitator and coordinator of research and training related to the environment and as a locus for environmental information. Grounding its activities in the Florida sub-tropical environment, the center's mandate encompasses global tropical and sub-tropical environments and issues related to water dominated ecosystems (Director, Colin Polsky)
- The Pine Jog Environmental Research Center is an environmental education center with the purpose of developing, providing and modeling environmental education programs which foster an awareness and appreciation of the natural world, promote an understanding of ecological concepts and instill a sense of stewardship toward the Earth and all its inhabitants (Director, Susan Toth)
- The Weppner Center for Civic Engagement's mission is to develop partnerships between the University and community by providing service opportunities to faculty, staff and students; and to promote the link between curriculum and service fostering civic awareness (Director, Nori Carter)
- The Institute for Sensing and Embedded Network Systems Engineering (I-SENSE) was established in early 2015 to coordinate university-wide activities in the Sensing and Smart Systems pillar of FAU's Strategic Plan for the Race to Excellence. The major theme areas of infrastructure systems, marine & environment, and medicine & behavior are of interest (Director, Jason Hallstrom)

C. Provide a narrative of the planning process leading up to submission of this proposal. Include a chronology in table format of the activities, listing both university personnel directly involved and external individuals who participated in planning. Provide a timetable of events necessary for the implementation of the proposed program.

In 2003, the Dean of the College of Engineering, Karl Stevens, came to a Department faculty meeting to discuss the University's strategic plan, which showed the creation of new degree programs related to the Department's strengths. At that time, several inquiries were made by Department faculty as to when the new degree proposal should be prepared, and in the meantime multiple versions of the proposal were developed. On July 1, 2009, the name of the Department of Civil Engineering was officially changed to the Department of Civil, Environmental & Geomatics Engineering after the merger of the Civil Engineering program with the Geomatics Engineering

program. In Spring 2009, CEGE faculty were instructed to prepare a proposal for a new doctoral degree program. The exploratory proposal was submitted to the Dean's office. Several versions of the feasibility study were generated over the next few years spanning changes in the Dean and Provost office leadership as well as a temporary institutional moratorium on new Ph.D. programs.

In 2013, the Department leadership changed, and a strategic plan was put in place involving 3 main objectives: 1) Strengthening the geomatics engineering program with renewed recruiting efforts and a pathway to a graduate degree, 2) Creating a joint doctoral degree with Ocean Engineering and also Computer Science as a prelude to established the Department's own degree program, and 3) Creating a new undergraduate degree program in Environmental Engineering. In 2014 at the behest of members of the Department Advisory Council, Dr. Meeroff requested a meeting with the Provost's Office with Drs. Michelle Hawkins and Russ Ivy. She explained the new procedures and expressed the Provost Office's general support for the proposed program.

In Spring 2018, an external market study was solicited from Hanover Research, and an external SACS accreditation review concluded that a Ph.D. program for the Department was necessary for the longterm success of CEGE's Strategic Plan emphasis on research and student success. The following timelines summarize the planning activities and implementation activities associated with this degree proposal.

Planning Process

Date	Participants	Planning Activity
Fall 2003	Yong, Sobhan, Nix, Reddy, Arockiasamy, Scarlatos	Department Advisory Council members approach the faculty to investigate a Ph.D. degree program, and the faculty develop an exploratory pre-proposal
Spring 2004 – Fall 2006	CEGE faculty	Feasibility studies performed
February 13, 2007	CEGE faculty	Revised draft of the Ph.D. proposal
November 14, 2007	CEGE faculty	Revisions solicited by the faculty to the Ph.D. proposal
Fall 2007 – Spring 2008	CEGE faculty and industry partners	Letters of support solicited from community partners
February 3, 2009	CEGE faculty	Exploratory committee established to revise the Ph.D. proposal
July 1, 2009	CEGE faculty	Department name changed to Civil, Environmental & Geomatics Engineering
March 29, 2011	CEGE faculty	Revised Ph.D. proposal for internal review
October 6, 2013	Interim Chair Yong, Meeroff, Kaisar, Bloetscher, Nagarajan, Stevanovic, Teegavarapu	Preliminary strategic plan and short term needs assessment for two year period of interim chair appointment (includes Ph.D. program)
October 19, 2013	Yong, Meeroff, Sobhan, Zilouchian, Ilyas	Feasibility study sent to the COE&CS Dean's Office for comment
October 22, 2013	Yong, Meeroff, Sobhan, Zilouchian, Ilyas	Modifications made to the feasibility study

Date	Participants	Planning Activity
February 20, 2014	OE, CEGE faculty	Negotiations begin on creation of the Sustainable Infrastructure track within the Ph.D. with Major in Ocean Engineering
Spring 2014	Hawkins, Ivy, Meeroff, Yong	Meetings with Provost Office to discuss pathway to new Ph.D. program in CEGE
April 22, 2014	Department Advisory Council, Alumni Advisory Council	Feasibility study and pre-proposal presented to the Department Advisory Council and Alumni Advisory Council for comment in a workshop format. Council members request faculty to move forward with the proposal.
Fall 2014 – Spring 2015	Yong, Bloetscher, Meeroff, Abbatte, Davis, Roberts, Bourassa, Dumbaugh	Revisions to the Ph.D. proposal to incorporate sustainable infrastructure engineering with participation from geoscience, urban and regional planning, architecture, and Harbor Branch
Fall 2015	OE, CEGE faculty	Faculty approve Sustainable Infrastructure Option in Ph.D. with Major in Ocean Engineering effective Spring 2016
December 12, 2017	Meeroff, Bloetscher	Surveys of SUS and nationwide doctoral curricula
December 20, 2017	Batalama, Yong, Meeroff, Bloetscher	Dean Batalama asks CEGE to prepare a new feasibility study for a Ph.D. program for the Department
February 14, 2018	Bloetscher, Meeroff, Yong, Peluso, Alperin, Szabo, Floyd	Inquiry into reducing the number of credits required by the Ph.D. program at the institutional level
February 28 – March 28, 2018	FAU Graduate Programs Committee, Graduate Council	FAU considers proposal to reduce doctoral credit hours for new programs from 80 to 72 beyond the bachelor's degree
March 19-20, 2018	Pezeshk, Schnabel, Xie	SACS external review concludes that a Ph.D. program is necessary for the future sustainability of the Department's research productivity
April 1, 2018	CEGE Faculty	Strategic Plan adopted by the faculty
April 30, 2018	Faculty Senate	Faculty approve 72 credit hours for new doctoral programs

Events Leading to Implementation

Date	Implementation Activity
March 5, 2018	Scope of work prepared for Hannover Marketing Group
April 10, 2018	Hanover debriefing from the interim report
June 6, 2018	Revisions to the market study scope
June 14, 2018	Provost Office approval for the updated market study
July 6, 2018	Graduate Dean's office notified of industrial partnerships for the proposed Ph.D. program
July 11, 2018	Initial comments of revised market study provided to Hanover
September 11, 2018	Revisions to the pre-proposal based on a market study
November 1, 2018	Additional feedback provided to a market study
November 13, 2018	Final revisions to the market study
December 23, 2018	Draft pre-proposal prepared for Provost Office review

Date	Implementation Activity
January 17, 2019	Pre-proposal and market study preliminary approval by the Provost's office
January 31, 2019	Preliminary comments solicited from the BOG from the FAU Provost's office
February 1, 2019	Additional edits to the pre-proposal after Dean's office and Provost's office review
February 8, 2019	Documents submitted to CAVP
February 21, 2019	More information requested by the Provost's office prior to CAVP meeting
February 22, 2019	CAVP meeting with a positive recommendation and minor comments
February 25, 2019	Full proposal template requested from the Provost's office
March 8, 2019	CEGE Department approval
March 11, 2019	College of Engineering and Computer Science Graduate Committee approval
March 20, 2019	UGPC approval
March 22, 2019	Academic Affairs approval
March 26, 2019	TASL approval
March 27, 2019	UGC approval
April 5, 2019	AP&BC approval
April 18, 2019	Steering Committee approval
April 29, 2019	Faculty Senate approval
	Board of Trustees Committee on Academic and Student Affairs approval
	Tentative Board of Governors approval

VII. Program Quality Indicators - Reviews and Accreditation

Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit. List all recommendations and summarize the institution's progress in implementing the recommendations.

All of our academic programs are accredited by the Southern Association of Colleges and Schools (SACS). Our undergraduate civil engineering and geomatics engineering programs are accredited by the Accreditation Board for Engineering and Technology (ABET). The last accreditation visit for the undergraduate civil engineering program review was in the Fall of 2014. The results were outstanding, with no concerns, deficiencies or comments. The undergraduate Environmental Engineering degree program will undergo its initial accreditation visit in Fall 2020. We anticipate the program will be accredited retrospective to Fall 2018.

In the 2018 BOG program review, the three reviewers (two external and one internal) wrote in the final report "a stated goal of the Dean and numerous faculty members is for CEGE to become nationally recognized for high quality education and research. Indeed, this comprises CEGE's vision statement. However, nationally-recognized high quality research is most often associated with programs that produce Ph.D. graduates. While MS students and undergraduates are certainly capable of producing high quality results, they tend to require significantly more oversight from faculty members to produce those results. Ph.D. students, due to their more advanced level of training, tend to be more capable of working on their own. As a consequence, a single faculty member can pursue numerous promising avenues of research working with Ph.D. students,

whereas they are more constrained working with MS students or undergraduates." They continued to write, "We believe CEGE requires a Ph.D. program if it seeks to become a nationally-recognized research leader. Students in that program must be able to focus their research as well as their coursework upon their specific area of expertise. Faculty members and administrators should closely consider the various options for getting there."

In Spring 2018, the CEGE faculty authored a strategic plan (Appendix F) that includes objectives, strategies, and measurable outcomes. The vision of the Department is to be nationally recognized as an eminent engineering program with excellence in education, research and community engagement, and its mission is to provide its engineering students with a high-quality education on fundamental concepts and engineering design, and to conduct cutting-edge research in urban mobility/infrastructure and water resources/environmental sustainability in state-of-the-art learning environments to benefit communities in Florida and beyond.

VIII. Curriculum

A. Describe the specific expected student learning outcomes associated with the proposed program. If a bachelor's degree program, include a web link to the Academic Learning Compact or include the document itself as an appendix.

Student Learning Outcomes

1. An ability to analyze and apply advanced knowledge of transportation and environmental engineering significantly beyond the master's degree level
2. An ability to communicate effectively with a range of audiences in written, oral, and graphical forms
3. An ability to independently conduct research, explore solutions to complex problems, apply fundamental concepts, demonstrate critical thinking and creative innovation, and create new knowledge related to transportation and environmental engineering

Program Educational Objectives

A. Graduates will advance the knowledge in science, technology, engineering and mathematics relevant to transportation and environmental engineering by engaging in lifelong learning, including professional licensure, developing new technologies, patents, and publications
B. Graduates will serve as effective professionals in careers consistent with the research-based foci of transportation and environmental engineering
C. Graduates will participate as leaders in emerging issues pertaining to transportation and environmental engineering for promoting local, regional and national economic and social development

Core Competencies

- Ability to complete a coordinated sequence of coursework as directed by the dissertation/supervisory committee
- Ability to gain practical experience in applied settings in the context of graduate internship
- Ability to generate new knowledge through research and other forms of scholarship
- Ability to understand fundamental principles of research methodology used in basic and applied research
- Ability to design and conduct novel research that adds to the body of knowledge of the discipline
- Ability to demonstrate advanced knowledge and expertise in a specific field relevant to transportation and environmental engineering

B. Describe the admission standards and graduation requirements for the program.

Admission Standards

1. Applicants must have a Master's Degree in Engineering, Science, Urban Planning, Transportation Logistics, or Mathematics from an accredited college or university. A student with outstanding scholastic achievement who holds only a baccalaureate degree may be admitted directly to this Ph.D. program and be eligible to earn the Masters' *en Passant* with a Master of Science with Major in Civil Engineering degree;
2. Applicants must have a 3.0 GPA (on a 4.0 scale) or better in the last 60 credits of work attempted and must have an official transcript forwarded directly to the FAU Graduate College from each college-level institution attended;
3. Applicants must submit the Graduate Record Examination (GRE) score. The GRE requirement can be waived with proof of passing the Fundamentals of Engineering (FE) or Principles and Practice of Engineering (PE) exam. The GRE requirement is waived for applicants that have a Master of Science degree from FAU's College of Engineering and Computer Science.
4. Applicants must demonstrate proficiency in both written and spoken English. A student from a non-English-speaking country is required to take the Test of English as a Foreign Language (TOEFL) and achieve a score of at least 550 (paper-based) or 213 (computer-based) or 79 (iBT). This requirement may be waived for students who have obtained a prior degree from a U.S. institution;
5. Applicants must submit to the Graduate College at least two letters of recommendation attesting to the student's ability to pursue with distinction a curriculum of advanced study and research in a chosen area;
6. Applicants should abide by the policies and regulations and the graduate admission requirements of the University as outlined in this University Catalog;
7. Conditional admission may be permitted if the above conditions are not met.

Graduation Requirements

The degree will be conferred on candidates who have fulfilled the following requirements:

1. Completed the curriculum for Ph.D. in Transportation and Environmental Engineering:
   - Successful completion of 72 credits of course and dissertation work beyond the baccalaureate degree with a minimum grade of "B." Up to 30 credits of coursework from an approved Master's Degree may be applied;
   - Students must maintain a minimum 3.0 GPA in all coursework attempted for the degree;

Core Course	Sustainability and Pollution Prevention	ENV 6932	3
Core Course	Transportation System Analysis	TTE 6501	3
	2 semesters of Graduate Seminar	CGN 5937	0
	Academic Specialization Electives*		15
	Dissertation (minimum)**		21

*Of the minimum 15 credits of Academic Specialization Electives, at least 12 credits must be at the 6000 level, and no more than 3 credits of directed independent study may be used to satisfy this requirement

** Up to 3 credits of graduate internship (EGN5940) can be used to satisfy the 21-credit dissertation minimum. These credits may not be taken until successfully passing the qualifying exam to enter candidacy

2. Successful completion of a qualifying exam is required prior to completion of 21 credits of coursework beyond the Master's Degree;
3. Successful completion of a dissertation proposal defense is typically required before registering for dissertation credits;
4. Prior to the dissertation defense, the student is required to have published or have accepted for publication a refereed research paper in a field of study deemed acceptable by the dissertation committee. A journal article is preferred, but a peer-reviewed conference paper is also acceptable;
5. Successful completion of an oral defense of the written doctoral dissertation based on original research in the student's area of specialization. The Dissertation/Supervisory Committee, the Department Chair and the Graduate College must have approved the dissertation and oral defense;
6. Complied with the University's Graduate Policies and Regulations and satisfied the University's Graduate Degree Requirements.

Dissertation/Supervisory Committee: Upon acceptance into the Ph.D. Program, a student will select or be assigned an advisor. The student's Ph.D. dissertation committee will have a minimum of four members. Three committee members must be from the FAU graduate faculty or associate graduate faculty according to the FAU Graduate College guidelines, at least one of which is from the Department of Civil, Environmental & Geomatics Engineering. The final member may be a qualified expert from industry or academia with affiliate graduate faculty status. One of the members shall serve as the chair of the supervisory committee. In unusual circumstances, with the approval of the Department Graduate Committee, two members may co-chair; however, off-campus experts or adjunct faculty may not serve as sole committee chair. The Dissertation/Supervisory Committee shall approve the plan of study, monitor academic progress, approve the dissertation topic, prepare, give, and evaluate the Qualifying Exam, evaluate the dissertation defense, and approve the final doctoral dissertation document.

Qualifying Exam: After successful completion of 21 credits of coursework beyond the Master's Degree and within 12 months of completion of graduate coursework, the student will be required to complete a qualifying examination. This written exam is in the field of concentration given by each member of the Dissertation/Supervisory Committee. Performance on any part of the qualifying exam in the judgment of the Dissertation/Supervisory Committee may result in a pass, fail, or fail with the option to re-take. Students may request in writing to repeat the exam. Students failing the Qualifying Exam twice will be dismissed from the program. After passing the Qualifying Exam with the approval of the dissertation/supervisory committee, a student advances to candidacy.

Proposal Defense: After successful completion of the Qualifying Exam and prior to applying for graduation, the candidate will orally defend the dissertation proposal to the Dissertation/Supervisory Committee for approval.

Dissertation Defense: The doctoral dissertation shall be written in the format specified by the Graduate College. The dissertation must be defended orally and represent an original piece of research that advances the body of knowledge in the field. A written dissertation is submitted to the members of the committee may approve, suggest additional work or reject the dissertation work after the defense.

C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives,

unrestricted electives, thesis requirements, and dissertation requirements. Identify the total numbers of semester credit hours for the degree.

Students entering the Ph.D. with Major in Transportation and Environmental Engineering with a bachelor's degree are required to complete 72 credit hours of graduate coursework, up to 30 credits of coursework from an approved Master's Degree may be applied, at least 21 credit hours must be formal coursework, 6 credits of core coursework (ENV 6932 - Sustainability and Pollution Prevention 3 credits and TTE 6501 - Transportation System Analysis 3 credits), at least 18 credits must be at the 6000 level, with 15 credits of academic specialization electives selected in consultation with the dissertation/supervisory committee, and a minimum of 21 dissertation credit hours with an optional graduate internship (0-3 credits). The student begins the curriculum by selecting an advisor and a dissertation/supervisory committee to create a plan of study. After passing the qualifying exam, the student advances to candidacy and begins taking dissertation credits. The proposal defense must occur after coursework is completed and prior to filing the intent to graduate. A publication is required prior to the dissertation defense.

D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.

A student in this program entering with a master's degree in Engineering, Science, Urban Planning, Transportation Logistics, or Mathematics from an accredited college or university begins the curriculum by selecting an advisor and a dissertation/supervisory committee to create a plan of study. The core foundations of the degree program include 6 credit hours (ENV 6932 - Sustainability and Pollution Prevention 3 credits and TTE 6501 - Transportation System Analysis 3 credits). The academic specialization includes 15 credit hours of specific elective courses to be determined in consultation with the dissertation/supervisory committee. After passing the qualifying exam, the student advances to candidacy and begins taking dissertation credits with an optional graduate internship (0-3 credits). The proposal defense must occur after coursework is completed and prior to filing the intent to graduate. A publication is required prior to the dissertation defense. The sequence of study is summarized in tabular form as follows:

Year/Semester	Course Number	Course Name	Credits
Year 1 Fall Semester	Select advisor, dissertation/supervisory committee & create a plan of study		
Year 1 Fall Semester	ENV 6932	Sustainability and Pollution Prevention	3
Year 1 Fall Semester	Elective 1		3
Year 1 Fall Semester	Elective 2		3
Year 1 Fall Semester	CGS 5937	Graduate Seminar	0
Year 1 Spring Semester	TTE 6501	Transportation System Analysis	3
Year 1 Spring Semester	Elective 3		3
Year 1 Spring Semester	Elective 4		3
Year 1 Summer Semester	Elective 5		3
Year 2 Fall Semester	Qualifying Exam, Advance to Candidacy		
Year 2 Fall Semester	EGN 7980	Dissertation	9
Year 2 Fall Semester	CGS 5937	Graduate Seminar	0
Year 2 Spring Semester	EGN 7980	Dissertation	6-9
Year 2 Spring Semester	Proposal Defense		
Year 2 Summer Semester	EGN 7980	Dissertation	1-3
Year 2 Summer Semester	EGN 6940	Graduate Internship	1-3
Year 3 Fall Semester	EGN 7980	Dissertation	1-3
Year 3 Fall Semester	EGN 6940	Graduate Internship	1-3
Year 3 Spring Semester	EGN 7980	Dissertation	1-3
Year 3 Spring Semester	EGN 6940	Graduate Internship	1-3
Year 3 Summer Semester	File Intent to Graduate, Publication, Dissertation Defense		

For students entering in the direct B.S. to the Ph.D. path, the sequence will include an additional 30 credits of coursework to obtain the *Master's en Passant*.

E. Provide a one- or two-sentence description of each required or elective course.

The following are the descriptions of the courses offered for the proposed Ph.D. program.

Core Classes:
Sustainability and Pollution Prevention (ENV 6932) 3 credits
This course introduces students to the principles of engineering sustainability, life cycle cost analysis, pollution prevention and environmental resource management of infrastructure planning and design.

Transportation System Analysis (TTE 6501) 3 credits
Concepts of operations research using various models to optimize holistic operations of transportation systems from the perspectives of sustainability, resilience, environmental impacts, and robustness. Programming model development and optimizations based on mathematical interpretations of descriptive problems.

College of Engineering and Computer Science Courses:

Graduate Internship (EGN 6940) 1-3 credits
Summer industrial work experience in student's major field of study. Grading: S/U

Dissertation (EGN 7980) 1-15 credits. Grading: S/U

Directed Independent Study (EGN 6908) 1-3 credits
Reading and research on selected appropriate topics.

Special Topics (EGN 6934) 1-3 credits
New developments and advanced work in specialized areas of engineering designed for individual student interest.

Elective Courses in CEGE:

Transportation Engineering Electives

Traffic Signal Systems (TTE 6259) 3 credits
This course teaches students about advanced concepts of traffic signal systems that are currently used in the U.S. Students design, evaluate and optimize various components of traffic signal operations both for individual intersections and coordinated traffic signal systems.

Highway Traffic Characteristics and Measurements (TTE 6505) 3 credits
This course instructs students on the concept of advanced traffic operations including the characteristics of functional relationships between traffic modeling and travel demand forecasting. Students evaluate transportation scenarios and design solutions to improve traffic operations.

Transportation and Supply Chain Systems (TTE 6507) 3 credits
A study of engineering decision problems for transportation and supply chain systems, relying primarily on the quantitative methods of operations research. Topics include an introduction to the components of logistics systems, such as suppliers, customers, inventory, orders and freight transportation systems and the interactions between these components; a thorough coverage of models and solution techniques for the design and control of logistics systems, primarily network and network-based optimization models; and study in the application of such models and solution techniques.

Maritime Freight Operations (TTE 6508) 3 credits

Addresses important transportation modeling techniques for maritime freight transport. Mathematical models are used to represent transportation problems, and commercial computer software packages are used to evaluate and investigate modern freight transportation systems.

Intelligent Transportation Systems (TTE 6272) 3 credits
Provides instruction on topics related to intelligent transportation systems, including theoretical fundamentals of systems engineering, traffic flow theory, architecture of telecommunications networks, freeway and arterial management and other topics related to ITS.

Airport Planning and Design (TTE 6526) 3 credits
Prerequisite: Permission of instructor
Factors influencing the selection of type, size and location of an airport, natural hazards and environmental impacts; selection of runway, taxiway, and apron configuration; air navigation aids and lighting.

Sustainable Public Transportation (TTE 6651) 3 credits
Designed to outline the principles of transit systems in the urban transportation arena, functional relationships that govern bus and rail transit, and issues associated with unbalanced flow and lane control, transportation system management and railroad economics and policies.

Railroad Engineering Design (TTE 6700) 3 credits
Prerequisites: Senior or graduate status; permission of instructor
Brief outline of the history of railroad development, nature of railroad traffic, location of rail routes, existing railroads, nature of materials hauled and locomotive power. These topics lead to specific details of the design and use, grades, geometry, foundations, materials, and rights-of-way of rail systems.

Highway Engineering (TTE 6815) 3 credits
Prerequisites: CEG 3011C, CWR 4202 and EGN 3331 or equivalent
Route selection including environmental impacts, vertical and horizontal alignment, intersection design, evaluation of subgraded soil strengths, and pavement design, drainage, and overlay design.

Environmental Engineering Electives

Water and Wastewater Treatment (ENV 5510) 3 credits
Prerequisites: CWR 3201C or equivalent, ENV 3001C or equivalent, and permission of instructor
This course introduces students to the principles and design of physical, chemical and biological treatment systems for potable and wastewater applications.

Hydraulic Systems Engineering (ENV 5565C) 3 credits
This class is outlines the concepts behind the design of piping and pumping stations. The class includes a review of hydraulics and piping networks, pipe materials, pump selection, multiple pump systems, sewer pumping networks and pump station design and appurtenances.

Air Pollution and Control (ENV 6115) 3 credits
Review of air quality and air pollution problems. Sources, characteristics, and effects of specific air pollutants; Lower atmospheric motion dynamics; Dispersion and interaction of pollutants in the atmosphere; Smog effects; Air quality standards and regulations; Air pollution control methods; Acid rain.

Solid Waste Management (ENV 6356) 3 credits
Quantities and composition of refuse; Municipal and industrial solid waste disposal methods; Sanitary landfills; Incineration; Grinding and composting of refuse; Energy recovery from solid wastes; Hazardous waste; Optimization techniques to solid waste operation and management.

Water Supply and Treatment (ENV 6418) 3 credits
Bacteriological, chemical, and physical water quality standards; distribution systems; water treatment theory and design; aeration; coagulation and flocculation; sedimentation; filtration; disinfection; softening; membranes.

Contamination of Aquatic Sediment (ENV 6441) 3 credits
Topics include: cohesive sediments, settling, re-suspension, aggregation, flocculation, pollutant adsorption/desorption; partitioning of chemicals, sediment toxicity assessment, bioassays/bioassessments, aquatic sediment sampling.

Wastewater Engineering (ENV 6507) 3 credits
Wastewater characterization, collection, and pumping. Physical unit operations and biological treatment unit process design including screening, sedimentation, filtration, activated sludge, disinfection, sludge digestion, and sludge disposal.

Environmental Systems and Processes (ENV 6668) 3 credits
Physical, chemical, and biological processes, reactor theory, particle transport, mass transfer, mixing, advection, dispersion, diffusion, sorption, phase transfer.

Water Resources Engineering Electives

Stormwater Modeling and Management (CWR 5308) 3 credits
The course presents a comprehensive view of stormwater modeling and management with an emphasis on current modeling techniques and design practices. The course provides an in-depth review of fundamentals of hydrology along with spatial analysis tools required for effective stormwater modeling and management.

Groundwater Flow (CWR 6125) 3 credits
Infiltration; Capillarity; Groundwater and Aquifers; Anisotropy; Groundwater motion; Darcy's law, Dupuit-Forcheimer's law; Potential flow; Flow nets; Conformal mapping; Unsaturated flow; Diffusion and dispersion; Well hydraulics, Theis equation; Drainage; Salt water intrusion; Legal doctrines; Economics of groundwater.

Open-Channel Hydraulics (CWR 6235) 3 credits
Review of basic hydraulics: Continuity, momentum and energy balance; Uniform and steady flow; Non-uniform flow; Critical flow; Gradually-varied flow; Surface profiles; Chezy's and Manning's formulas; Laminar and turbulent flow; Velocity distribution; Unsteady flow; Rapidly varying flow; Flood routing; Design of open-channels.

River Mechanics and Sediment Transport (CWR 6236) 3 credits
Properties and classification of sediments; dimensional analysis; bed configuration; initiation of particle motion; Shield's curve; bedform resistance to flow; sediment discharge; bedload; washload; suspended sediments; stream characteristics; river meandering; regime methods; river training methods.

Dynamic Hydrology (CWR 6525) 3 credits

Dynamics and statistics of principal hydrometeorological processes; Hydrologic cycle; Precipitation, Infiltration; Evapotranspiration; Surface runoff; Percolation; Groundwater motion; Stormwater management; Hydrologic modeling; Water budget; Hydrologic time series, Stochastic analysis; ARARMA models.

Water Resource System Engineering (CWR 6818) 3 credits
Nature of water resource systems; Systems analysis, Objective functions; Optimal policy analysis; Linear programming; Dynamic programming; Political and economic objectives; Water resource subsystems; Deterministic and stochastic parameters; Large-scale, multi-objective projects; Water allocation; Supply and demand; Hierarchical modeling of water resource systems.

Modeling Methods in Water Resources and Environmental Engineering (EES 6025) 3 credits
Classification of PDEs; fundamentals of numerical analysis; numerical stability, consistency, and convergence; method of characteristics; variational principles; finite differences; finite elements; integral-boundary element method; applications to water resource and environmental engineering problems.

Stream, Lake and Estuarine Pollution (EES 6357) 3 credits
Physicochemical and biological properties of open-water systems; Energy balance; Entrophy; Thermodynamics; Photosynthesis; Zooplankton; Nutrients; Bacteria and protozoa in pollutant degradation; Michaelis-Menten models; Thermal pollutant; Heat exchange; Stratification; Sedimentation, Management alternatives for water quality control.

Geomatics Engineering Electives

Terrestrial Laser Scanning (CEG 5304C) 3 creditsThis course gives an introduction to applications of terrestrial laser scanning systems in geosciences, engineering, urban planning, forestry, architecture, emergency planning and forensics.

Utilities Engineering Electives

Civil Engineering Project Management (CCE 5036) 3 creditsThis is a course in which planning, design, document preparation, bidding, big tabulation, construction management, cost estimation, conflict resolution and scheduling for civil engineering projects are covered.

Advanced Energy Engineering/Energy Engineering (CGN 5715) 3 credits
This course provides an overview of renewable energy technology. It outlines the basic principles of solar electricity, solar water heating, wind power, micro-hydro, biomass and heat pumps and their application in urban and rural environments.

Design and Analysis for Engineering Data (CGN 5716) 3 credits
Prerequisites: Basic course in statistics or permission of instructor
Course covers development of hypothesis and thesis-driven data analysis via applications of the basic principles of experimental design to analysis of engineering data, computational algorithms for sample size optimization, analysis of variance for experiments with a single factor, multi-variate analysis.

Infrastructure Maintenance and Management (CGN 6616) 3 credits
The course involves evaluating infrastructure systems (water, sewer, stormwater, roads, bridges, rail, power) to identify concepts on repair, replacement and maintenance, including dollars to spend on same.

Geotechnical Engineering Electives

Advanced Soil Mechanics (CEG 6015) 3 credits
Fundamentals of soil behavior including dynamic soil properties; subsurface explorations and sampling; elastic and probabilistic analyses for stresses in soil masses; wave propagation in soil media; foundation vibrations; liquefaction; critical state model for soil behavior.

Advanced Foundation Engineering (CEG 6105) 3 credits
Rigid and flexible earth retaining structures; shallow and deep foundations; laterally loaded piles; sheet-pile walls, braced excavations, cellular cofferdams, and buried culverts; consolidation settlement, stress distribution, elastic settlement, load bearing capacity; seepage and dewatering of foundation excavations.

Geotechnology of Waste Management (CEG 6113) 3 credits
Forms of waste; index properties; clay minerals; compressibility and settlement; shear strength; hydraulic properties; site investigation; site selection; ground modification and compaction; liners; leachate generation and collection caps; foundation and slope stability; gas management, computer modeling for landfill design.

Soil Stabilization and Geosynthetics (CEG 6124) 3 credits
Soil chemistry, mineralogy, and properties; techniques of soil reinforcement, soil improvement, and soil treatment; chemical stabilization; mechanical stabilization; designing with geosynthetics; foundations and pavement applications.

Pavement Analysis and Design (CEG 6129) 3 credits
Stresses and strains in flexible and rigid pavements, materials characterization, pavement performance, mechanistic design principles, AASHTO design method, pavement rehabilitation.

Numerical Methods in Geotechnical Engineering (CEG 6505) 3 credits
Dynamic and static analysis of shallow and deep foundations, flow-through porous media, excavations, embankments, one-, two- and three-dimensional consolidation and earthquake response analysis.

Groundwater Contamination (CEG 6708) 3 credits
Sources and types of groundwater contamination; hydrogeologic site investigations; contaminant transport mechanisms; contaminant fate processes; modeling of groundwater contamination; non-aqueous phase liquids; groundwater remediation methods.

Structural Engineering Electives

Advanced Structural Analysis (CES 6106) 3 credits
Review of matrix-force and displacement methods and their applications to civil structures.

Advanced Mechanics of Materials for Civil Engineers (CES 6107) 3 credits
Stress and strain tensors, failure criteria, variational principles, torsion of thin wall members, unsymmetrical bending, theories of plates, shells, elastic foundations, and plastic analysis of structures.

Finite Element Methods in Civil Engineering (CES 6119) 3 credits
Variational principles, weighted residual methods, convergence criteria, shape functions for one-,

two-, and three-dimensional elements, isoparametric elements, and applications to structural and geotechnical engineering systems.

Bridge Design (CES 6325) 3 credits
Planning, design, and construction of bridges. Discussion of bridge types and factors affecting the selection of type: concrete versus steel, prestressed, composite, segmental concrete bridges; design issues and techniques; detailed case study of a particular bridge; recent technological developments in bridge engineering.

Advanced Concrete Materials (CES 6502) 3 credits
Cementitious and pozzolanic material-modified concretes. Modification with fly ash and high volume fly ash; silica fume; ground granulated blast furnace slag; rice husk ash; municipal ash; polymeric waste. Other concretes—fiber reinforced, lightweight expanded polystyrene (EPS); metakaolin; pervious; Shotcrete, wood ash/municipal ash/polymeric waste modified.

Structural Dynamics (CES 6585) 3 credits
Response of lumped parameter systems to dynamic loading: formulation and solution of problems of one or more degrees of freedom for discrete systems, modal analysis, numerical integration, and transform techniques. Response of continuous systems. Introduction to earthquake engineering: response spectra, energy absorption capacity of structures, estimation of damping, seismic design, seismic codes, and soil-structure interaction. Wind effects on structures and hurricane-resistant design. Blast-resistant design. Approximate design methods.

Advanced Steel Structures (CES 6607) 3 credits
Review of basic steel design; beam columns; interaction formulas; first-order and second-order moments; eccentric bolted and welded connections; moment resisting connections; composite construction; effective flange width; shear connectors; composite beams with formed steel deck; plate girder proportions; AISC requirements; flexure-shear interaction.

Advanced Reinforced Concrete (CES 6706) 3 credits
Analysis and design of two-way slabs, floor systems, deep beams, shear walls and footings. Limit state, yield line and deflection analysis. Continuity, tall buildings, seismic, and hurricane-resistant design. Torsion.

Prestressed Concrete (CES 6715) 3 credits
Behavior, analysis and design of pretensioned and post-tensioned concrete structures flexural, shear, bond and anchorage zone design; partial prestressing strength, serviceability and structural efficiency of beams, slabs, tension and compression members; frameworks and bridges.

Elective Courses Outside CEGE Offerings:

Electrical Engineering and Computer Science Electives

Data Mining for Bioinformatics (CAP 6546) 3 credits
Course focuses on the principles of data mining as it relates to bioinformatics. Topics covered include gene selection, class imbalance, classification, biomarker discovery and prediction models. No prior knowledge of biology is required.

Machine Learning for Computer Vision (CAP 6618) 3 credits
Introduction to machine learning techniques and their application in computer vision problems. Discusses image processing principles, techniques and algorithms. Use of MATLAB for lab

assignments and projects.

Introduction to Bioengineering (BME 5000) 3 credits
Course provides a broad perspective of bioengineering as applied to topics in contemporary biology, physiology, and medicine, including biotechnology and bioinformatics.

Biosystems Modeling and Control (BME 5742) 3 credits
Dynamic modeling and control of select biological and physiological processes.

Stem Cell Engineering (BME 6324) 3 credits
Focuses on the stem cell's research and engineering to clarify the nature of these cells, their sources and categories, their engineering for different purposes, their role as cellular therapeutic approach, reprogramming of ordinary cells into stem cells through a combination of readings, penetrating discussions and animation of new techniques and tools (short movies).

Tissue Engineering (BME 6334) 3 credits
Principles and newest concepts of tissue engineering. Learning and studying molecular, cellular and tissue culture aspects of TE and Laboratory work and high level of instrumentations that helps this Laboratory work to grow the tissues. Mechanical functions of the cells, extracellular matrix, types, quality, purposes of scaffolds as the supporters of 3-D tissue growth, discussed.

Bioinformatics: Bioengineering Perspectives (BME 6762) 3 credits
Introduction to bio- and genetic-engineering. Concepts and definitions of molecular biological terms. Bioinformatics-definition and applications. Information resources and databases: Proteins and genomes. Biological sequence analysis and applications. Sequence search/analysis tools and protocols. Bioinformatics versus modern information networks and the World Wide Web.

Biosignal Processing (EEE 5286) 3 credits
This course covers the generation of bioelectrical signals, their acquisition, modeling and analysis. Modeling and analysis tools cover adaptive filtering, time-frequency analysis, model-based spectral analysis, stochastic signals and signal representation in orthogonal bases: wavelet transforms.

Nanobiotechnology (EEE 5425) 3 credits
This course covers the sensing and characterization of biological entities with novel nanoscale devices and nano-object mediated modalities. It also covers the fundamentals of nanotechnology in biological and biomedical research.

Digital Processing of Signals (EEE 5502) 3 credits
An analysis of discrete signals and systems, difference calculus, sampling theory, Z-transform and the discrete Fourier transform, digital filter synthesis and implementation, and fast Fourier transform algorithms.

Adaptive Signal Processing (EEE 6504) 3 credits
This course covers the principles of linear adaptive filtering, various adaptive filtering techniques, and their relationships to optimal linear filter solutions. Also emphasized are such applications such as adaptive filtering as noise and echo cancellation, adaptive equalization, line enhancement, and beamforming.

Advanced Signal Processing (EEE 6508) 3 credits
Course provides an in-depth study of a select set of topics in digital signal processing (DSP). Topics

include advanced digital filter design techniques, reconstruction of signals from DSP samples, wavelets, and multirate signal processing and its applications to speech analysis. Course is designed for graduate students with a strong background in DSP fundamentals and MATLAB.

Smart Grid (EEL 5291) 3 credits
Exposes students to concepts, theories, methods and latest topics in smart grids. Topics covered include principles and practices in data analytics, optimization, control, renewable energy and electrical power systems.

Microwave Engineering (EEL 5437) 3 credits
Electromagnetic theory, harmonic transmission lines, waveguides, microwave network analysis, impedance matching and tuning, microwave resonators, powder dividers, couplers and filters, microwave oscillators and mixers, CAD design techniques.

Robotic Applications (EEL 5661) 3 credits
Robot classification, robot systems, economic justification; product design for robot assembly; programming, part feeding, tooling.

Information Theory (EEL 6532) 3 credits
Information theory, entropy, coding information sources, noisy channels, codes for error detection and correction.

Detection Theory (EEL 6537) 3 credits
Hypothesis testing; detection of signals and noise; detection of signals with unknown parameters; detection of weak signals; non-parametric detection; decentralized detection; robust detection; and applications.

Intelligent Control (EEL 6682) 3 credits
Recent trends related to learning and decision-making capabilities of intelligent control systems using neural networks and fuzzy logic. Emphasis on controller design for industrial applications.

Neural Complex and Artificial Neural Networks (EEL 6819) 3 credits
Multifaceted representation of neural activity in terms of neurobiology, cognitive science, art of computation, cybernetics and physics of statistical mechanics. Neural network modeling mimicking biological neural complex and development of artificial neural networks.

Ocean and Mechanical Engineering Electives

Optimal Control Systems (EEL 6672) 3 credits
The optimization theory is applied to continuous and discrete dynamic systems.

Mechanics of Composite Materials (EGM 6562) 3 credits
An introduction to composites, basic principles of elasticity, unidirectional composites, short-fiber composites, laminated composites, strength analysis, composite designs, joint criteria, and test methods.

Failure Prevention (EML 6233) 3 credits
Modes of mechanical failure, strength and deformation of metals, theories of failure, fatigue and fracture, life prediction, statistics, fretting, wear, and corrosion.

Mechanical Properties of Polymers (EML 6235) 3 credits

Review structure and processing of methods of engineering plastics; structure-property relationships, analysis of creep and stress relaxation; viscoelastic models; dynamic-mechanical response; rubber elasticity.

Fracture Mechanics (EML 6239) 3 credits
An introduction to linear elastic fracture mechanics. It studies deformation response of materials, toughness, fatigue and fracture, environmentally assisted cracking, experimental methods, and data reduction.

Topics in Biomechanical Engineering (BME 5930) 3 credits
Study relating to specialized topics associated with biomechanical engineering including, but not limited to, biomechanics, bio-fluid mechanics, biosensors and MEMS, and nanotechnology.

Biomaterials (BME 6105) 3 credits
This course covers the knowledge of biomaterials in science and engineering. All types of biomaterials as well as their applications in biomedical fields are introduced and discussed extensively.

Molecular, Cellular, and Tissue Biomechanics (BME 6222) 3 credits
Introduction to biomechanical phenomena over a range of length scales from molecular to cellular to tissue levels.

Nanotechnology (BME 6572) 3 credits
An introduction to nanotechnology through lectures, demonstrations, and projects covering fundamental science behind nanotechnology; tools for nanosciences; smart materials; sensors; biomedical applications; energy capture, transformation, and storage; optics and electronics; fabrication and modeling; and the nano business, nano industry.

Introduction to Finite Element Methods (EGM 5351) 3 credits
Application of finite element programs to problems in heat transfer, fluid mechanics, vibration, stress analysis and machine design.

Advanced Strength of Materials (EGM 6533) 3 credits
Elements of plane elasticity, failure theories, and advanced topics in bending and torsion of structural elements. It serves as an introduction to finite element methods and applications in machine design.

Theory of Elastic Stability (EGM 6736) 3 credits
Prerequisite: Graduate standing
Introducing the principles and theory of structural stability and the buckling characteristics of structures such as beams, columns, thin plates, etc., and postbuckling of structures.

Mechanical Vibrations (EML 6223) 3 credits
Step and impulse loads, multiple degrees of freedom, influence coefficients, matrix methods, vibration of continuous systems, Lagrange's equations. This course serves as an introduction to non-linear and random vibrations.

Advanced Random Vibrations (EML 6229) 3 credits
Spectral analysis of linear discrete and continuous systems; theory of diffusive Markov process as applied to non-linear problems; stability and bifurcation of randomly excited systems; excursion and fatigue failures.

Advanced Engineering Dynamics (EML 6271) 3 credits
A course in three-dimensional kinematics and kinetics of particles and rigid bodies, Lagrangian mechanics, Hamilton's principle, and engineering application to discrete and continuous systems.

Conduction Heat Transfer (EML 6154) 3 credits
Steady state and transient conduction heat transfer in one- and multidimensional geometries. It emphasizes analytical methods, exact and approximate. Numerical techniques are also included.

Convection Heat Transfer (EML 6155) 3 credits
The solution of equations governing momentum and heat transfer. Applications include convective heat transfer for internal and external flows.

Advanced Control Systems (EML 6317) 3 credits
Control design applications via root locus and frequency-based approaches are explored theoretically and applied to laboratory systems. Nonlinear sliding mode control theory is introduced and applied to a lab system. Each student also explores an individual project based on control of a system.

Turbomachinery (EML 6402) 3 credits
Performance characteristics of turbomachines, basic laws, the cascade theory, the thin airfoil theory, inviscid flow in three dimensions, boundary layers, axial flow turbines.

Solar Energy Engineering (EML 6417C) 3 credits
The fundamentals of solar radiation, transmission, and absorption; flat plate and focusing collectors, thermal storage, heating and cooling of structures, distillation, process heat generation, and power generation. Two hours lecture and six hours lab are required.

Wind Turbine Systems (EML 6456) 3 credits
This course reviews wind turbine systems and practical means of harnessing green energy. The course covers turbine technology, power rating and efficiency, blade-hub-nacelle-tower systems, wind data analysis, turbulence and rotational sampling, rotor aerodynamics, control systems, economics and environmental aspects.

Advanced Fluid Dynamics (EML 6716) 3 credits
A survey of fluid dynamics, this course addresses the fundamental principles and their applications in a variety of engineering and science problems. Topics covered include dimensional analysis, kinematics, dynamics, inviscid flow, viscous flow, vorticity, boundary layer, turbulence, compressible flow, flow with gravity and flow of industrial and natural processes.

Computational Gas Dynamics (EML 6724) 3 credits
An introductory discussion of solving fluid dynamic problems through numerical computations. Gaseous medium includes compressible and incompressible fluid.

Advanced Computational Fluid Dynamics (EML 6726) 3 credits
Course is designed for advanced use and application of CFD for practical engineering flows. Topics covered include governing equations, numerical methods, geometry and mesh generation using Gambit, CFD package Fluent (solver), specific applications (turbulent flow, heat transfer, combustion), post processing, and validation of CFD data.

Experimental Fluid Mechanics and Heat Transfer (EML 6735C) 3 credits

Development of diverse topics of experimental research in fluid mechanics and heat transfer, discussion of tools needed in the description and analysis of experimental data, individual experimental methods such as hot wire anemometry, laser-Doppler anemometry etc., data acquisition techniques and computer data analysis, design of experimental apparatus utilizing the above techniques.

Mathematical Methods in Ocean Engineering 1 (EOC 5172) 3 credits
First of a two-course sequence of mathematical methods in solving ocean engineering problems in hydrodynamics, vehicle dynamics, acoustics and vibrations, ocean structures, and electrical and mechanical systems.

Experimental Fluid Dynamics (EOC 6126) 3 credits
Course presents basic theory and practical application of various methods in experimental fluid dynamics with a special emphasis on optical measurement techniques. Topics include construction of flow facilities, thermal anemometry, acoustic Doppler velocimetry, dye and hydrogen bubble flow visualization, particle image velocimetry (PIV), stereo PIV, holography, and digital holography.

Advanced Fracture and Failure Processes 1 (EOC 6157) 3 credits
Advanced treatment of microscopic and macroscopic theories of plastic deformation, strengthening mechanisms, and fracture; fracture mechanics, fatigue and environmental cracking, stress corrosion cracking, corrosion fatigue and hydrogen embrittlement. Emphasis is on materials employed in structural marine applications.

Mathematical Methods in Ocean Engineering 2 (EOC 6174) 3 credits
Second of a two-course sequence of mathematical methods in solving ocean engineering problems in hydrodynamics, vehicle dynamics, acoustics and vibrations, ocean structures, and electrical and mechanical systems.

Advanced Hydrodynamics 1 (EOC 6185) 3 credits
Prerequisite: Graduate standing or permission of instructor
A two-semester sequence providing a comprehensive and rigorous background in hydrodynamics for ocean engineering graduate students. The course will cover development of basic equations and fundamental approximations, potential flow, low and high Reynold's number flows, turbulence, and boundary layers. It employs basic analytic and numerical methods of problem solving.

Advanced Hydrodynamics 2 (EOC 6186) 3 credits
The second course in a two-semester sequence providing a comprehensive and rigorous background in hydrodynamics for ocean engineering graduate students. The course will cover development of basic equations and fundamental approximations, potential flow, low and high Reynold's number flows, turbulence, and boundary layers. Basic analytic and numerical methods of problem solving are used.

Computational Fluid Dynamics (EOC 6189) 3 credits
A systematic instruction of computing techniques for fluid flow including fundamentals of computational fluid dynamics, finite difference methods for incompressible flow, finite element simulation, and numerical methods in free-surface flow.

Turbulent Flow (EOC 6190) 3 credits
An introduction to turbulent transport of momentum and heat, the dynamics of turbulence, wall-

bounded shear flows, boundary-free shear flows, turbulent diffusion, shear flow dispersion.

Corrosion 1 (EOC 6216C) 3 credits
Theory of corrosion with regard to electrode potential, polarization and passivity, and corrosion prevention; techniques in corrosion research; corrosion and corrosion prevention in the marine environment.

Corrosion 2 (EOC 6218C) 3 credits
The theory of corrosion with regard to electrode potentials, polarization, and passivity as well as corrosion prevention. It covers techniques in corrosion research; corrosion and corrosion prevention in the marine environment.

Physical Metallurgy (EOC 6230) 3 credits
The theoretical aspects of physical metallurgy: the structure of atoms and crystals, laboratory techniques, thermodynamics of metals, structure of alloys, dislocation theory.

Sonar System Designs (EOC 6310) 3 credits
Transduction, electromechanical equivalent circuits, sonar equations, radiation, transmission loss, reverberation, target strength, noise sources and fields, telemetry, signal detection, acoustic signal processing, beam forming, modeling sonar signals, sonar performance, transceiver electronics.

Flow Noise (EOC 6311C) 3 credits
Sound generation by flow, Lighthill's analogy, dipole and quadrupole noise, noise and unsteady loading from propellers, blade response functions, trailing edge noise, ducted propellers, propagating modes, sound power calculations with flow.

Ocean and Seabed Acoustics (EOC 6312) 3 credits
Course provides an overview of ocean and seabed acoustics including the theory of underwater sound generation, propagation, and reception that is required for the design of sonar systems and acoustic experiments.

Engineering Principles of Acoustics (EOC 6317C) 3 credits
The physical principle of acoustics, governing equations and their solutions, bounded and unbounded media, sources, sound generation propagation and measurement.

Advanced Ocean Wave Mechanics (EOC 6320) 3 credits
Linear and non-linear wave theory, nearshore ocean wave dynamics, hydrodynamics of floating bodies, the introduction of wave stability and solutions.

Coastal Structures (EOC 6430) 3 credits
An overview of basic concepts: environmental loading, seawalls, bulkheads and revetments, groins, jetties, breakwaters and cylindrical structures, wharves, quays, fenders, dolphins, and mooring devices, littoral drift and sedimentation problems, planning of coastal protection.

Offshore Structures (EOC 6431) 3 credits
Basic structural systems, environmental loading, fixed and gravity type platforms, semi-submersibles, floating and compliant platforms, external pressure shell structures including oil storage tanks, pipelines, wet and dry subsea completion systems, buoy engineering, concepts for frontier areas, dynamic response.

Ocean Instrumentation (EOC 6625) 3 credits

Provides an overview of instrumentations and data analysis that are required for design, fabrication and calibration of ocean systems, such as platforms and offshore structures, autonomous underwater vehicles, surface vessels, underwater imagery, pressure vessels and pipelines.

Signal Processing (EOC 6630) 3 credits
Theory of information processing with particular applications in the fields of communication and sonar.

Engineering Data Analysis (EOC 6635) 3 credits
Fourier transform applications to the processing of ocean engineering related types of signals, time and frequency domain analysis of signals, signal processing techniques, laboratory work involving actual ocean time series data using modern data acquisition systems.

Intelligent Underwater Vehicles 1 (EOC 6663) 3 credits
Engineering principles for intelligent, unmanned, untethered, underwater vehicles (IU3 vehicles). Topics include vehicle kinematics; and tasks, behavior, locomotion, power sources and sensors.

Physical Aspects of Oceanography (OCP 6050) 3 credits
Prerequisite: Admission to graduate program in Ocean Engineering
A critical review of physical, chemical, and geological oceanography. Extensive assigned reading, seminars, etc. are required.

Architecture Electives

Introduction to Urban Design (ARC 6305) 3 credits
This course examines various urban theories and architectural conceptualizations, and their relationship to the spatial structure of the urban environment. Lectures and seminar presentations will permit investigation and critical evaluation of urbanism as seen through various professional contexts and philosophies. By situating the analyses in the wider domain of culture, architecture, planning and governance, discussions will range from personal to institutional.

Design in Urban Redevelopment (ARC 6365) 3 credits
Beginning with an overview of the processes that control change in the built environment, the course analyzes current and future opportunities for Broward County as they are influenced by the wide range of decision-makers including financiers and public agencies. Students will develop design concepts that meet public goals and offer enhanced opportunities for the improvement of the quality of life.

Sustainability and Tropical Architecture (ARC 6598) 3 credits
Introduction to sustainable design concepts related to the climatic conditions of the local region. Topics cover old/new technologies, protection of the environment, health and safety of occupants, and durability of materials that are affected by the tropical climate. Students develop a set of design guidelines incorporating these concepts in response to a location in the south Florida/Caribbean region.

Design for Human Health (ARC 6691) 3 credits
Investigation the "Consensual Essence of Architectural Spaces." Readings examine ancient myths, non-Western beliefs and building practices, and recent achievements of medical science and brain research. Guest lecturers, class discussions, and student research help answer the course's fundamental question: Is architecture and its product—a building—capable of influencing the

prevention and cure of illnesses in positive way?

Public Administration Electives

Public Administration and Public Policy (PAD 6036) 3 credits
A critical examination of the role of public administrators in setting the public agenda, formation of action strategies, execution of preferred action strategy, and evaluation of the impacts of the preferred strategy. M.P.A. core course.

Introduction to Public Administration (PAD 6053) 3 credits
An analysis of the contemporary political, economic, and social institutions and processes in which the profession of public administration is practiced. M.P.A. core course.

Managerial Leadership in State and Local Government (PAD 6063) 3 credits
Covers fundamental managerial and leadership aspects of state and local governments. Explores personal, ethical, organizational, political, and legal dimensions of governance in state and local governments.

Organization and Administrative Behavior (PAD 6106) 3 credits
Analysis of the formal, informal, and societal characteristics of complex human organizations. Use is made of standard theories of organizations as well as of their more contemporary variations. M.P.A. core course.

Decision Making in the Public Sector (PAD 6135) 3 credits
Course focuses on decision-making tools used in the public and nonprofit sectors. The tools are applied using case studies and projects.

Strategic Planning in the Public Sector (PAD 6333) 3 credits
Study of strategic planning and how to apply that knowledge to real world organizations.

Regulation (PAD 6612) 3 credits
The course analyzes how and why bureaucracies develop regulations and the role that regulations play in the policy process with a focus on the economic, political, administrative, and social factors that influence regulatory choices and the impacts of those regulations.

Urban and Regional Planning Electives

Legal Aspects of Planning (URP 6131) 3 credits
An overview of the legal issues in planning and discussion of the regulatory processes that enable planners to shape community growth and development.

Planning Methods 1 (URP 6200) 3 credits
Quantitative reasoning skills in urban and regional planning; development of appropriate computer skills.

Statistics for Urban Planning (URP 6211) 3 credits
This course provides an introduction to statistics with emphasis on applications to practical problems relevant to urban planning.

Introduction to GIS in Planning (URP 6270) 3 credits
Overview of planning information systems, including basic terminology, tools, and policy issues.

Lab fee: $10 per student.

Managing GIS Projects (URP 6272) 3 credits
Organizational and management issues involved in implementing geographic information systems.

GIS Applications in Planning (URP 6277) 3 credits
This course provides urban and regional planning applications of GIS. Included are demonstrations of environmental planning, community and economic development planning, urban design, and land use planning. Students learn to use GIS as a tool for decision-making.

Sustainable Cities (URP 6406) 3 credits
Explores the intellectual foundations and historical development of sustainability as a concept, places it within the larger context of various development theories and looks at how it has influenced real-world practice in planning and public policy.

Environmental Analysis in Planning (URP 6425) 3 credits
Analysis of natural and urban environments, and the application of planning systems.

Environmental Policy and Programs (URP 6429) 3 credits
Policy and analytic perspectives on major issues in environmental planning systems.

Tourism and Economic Development (URP 6540) 3 credits
An overview of urban and local economic development including methods and techniques, development, finance, and instruments for system change.

Urban Revitalization Strategies (URP 6545) 3 credits
Detailed examination of economic, management, and design tools in local economic development planning.

Economic Development Planning (URP 6549) 3 credits
Policy and analytic perspectives on major issues in community and economic development planning systems.

Introduction to Transportation Planning (URP 6711) 3 credits
Overview of transportation planning, methods, and emerging planning issues.

Capital Facilities Planning (URP 6732) 3 credits
Planning systems and analytical techniques for urban infrastructure.

Urban Development and Design (URP 6841) 3 credits
Overview of urban development processes, including basic terminology, tools, and policy issues.

Site Planning (URP 6873) 3 credits
Principles and basic methods of site planning and site plan evaluation; development design guidelines; site plan approval process.

Urban Design (URP 6881) 3 credits
Elements, concepts, and methods of urban design. Analysis of urban form; methods of implementation.

Urban Design Workshop (URP 6886) 3 credits
Application of physical planning skills to a selected urban design problem; district or project scale.

Planning Workshop (URP 6920) 3 credits
Individual and team approaches to resolving planning problems and issues.

Environmental Science Electives

Environmental Restoration (EVR 6334) 3 credits
Course introduces students to the rapidly expanding practice of restoring degraded ecosystems and landforms through a mixture of lecture, discussion, field visits, and individual research projects.

Restoration Implementation and Management (EVR 6358) 3 credits
Restoration projects require the approval of multiple government agencies and cooperation of affected landowners and stakeholders at every phase. This course covers the legal aspects of government approval, creating communication plans for coalition building and collaboration with stakeholders, conflict resolution and ethics in restoration. The course uses a combination of discussion of academic literature, lecture, case studies and guest speakers, including from state and federal agencies, consulting firms and non-governmental organizations.

Human-Environmental Interactions (GEA 6277) 3 credits
This course provides graduate students in geography with an environment to practice the various methods and approaches learned in their graduate program. It uses a multidisciplinary approach to explore diverse aspects of human-environment interactions in a specified region.

Biogeography (GEO 5305) 3 credits
Biogeography is the study of distributions of organisms and the processes responsible for the patterns. This course examines theories concerning spatio-temporal processes and patterns, populations, communities, ecosystems, biodiversity, disturbance, succession, speciation and conservation. Classes are taught by lecture, discussion of academic literature and field-based research at local sites.

Geosciences Electives

Environmental Geochemistry (GLY 5243) 3 credits
Examination of current geochemical problems affecting the earth at global, regional, and local scales. Discussion of the natural geochemical background of substances including a review of geochemical principles.

Shore Erosion and Protection (GLY 5575C) 3 credits
Study of geomorphology and use of coasts, sediment budgets and dune-beach interaction, effects of engineering structures, coastal hydraulics, tides and currents, waves and structures, coastal water level fluctuations, shore erosion control, beach replenishment, coastal protection and restoration, fate of replenished beaches.

Marine Geology (GLY 5736C) 3 credits
Theoretical and applied earth science in the marine environment. Introduction to the history of marine geology, structure and evolution of continental margins and the world's basins in terms of modern plate tectonic theory, ocean sediments and sedimentary regimes, geologic effects of waves and currents, dynamics of coastal environmental processes, fluctuations of mean sea level through

time, ocean mineral resources.

Advanced Topics in Applied, Coastal, and Hydrogeology (GLY 5934) 3 credits
Occasional advanced courses in specialized areas of engineering, coastal and hydrogeology not fully covered in other program courses.

Advanced Environmental Geochemistry (GLY 6246) 3 credits
A study of the principles of geochemistry as they are applied to environmental problems relating to water. Hydrogeology includes study of contamination of surface and underground terrestrial water and coastal waters. The course will familiarize students with the methods, capabilities, and jargon of geochemistry as it applies to their areas of interest.

Environmental Geophysics (GLY 6457) 3 credits
An introduction to near-surface geophysical methods for mapping the ground at shallow depths. Emphasis on electromagnetic and electrical methods such as ground penetrating radar (GPR) and resistivity imaging specifically for environmental applications. A field-based case study using an integrated array of real geophysical data sets collected in a local site will be conducted to give students a practical approach to applied geophysical methods.

Coastal Environments (GLY 6737) 3 credits
Dynamics of depositional systems in coastal environments. Emphasis on variability of sediments, geomorphology and littoral processes associated with coastal dunes, lagoons, estuaries, beaches and nearshore environments.

Global Environmental Change (GLY 6746) 3 credits
An introduction to the study of global climate change through time. Included and in-depth studies of the causes of and evidence for past environmental changes, major perturbations of global natural environmental systems, the effects of sea level changes, solar variations, and planetary dynamics on climate, and details of Quaternary paleoclimate models.

Groundwater Solute Transport Modeling (GLY 6828) 3 credits
Studies the mechanisms that govern the movement of water and pollutants in aquifers. Develops a complete conceptual model and overviews a sound mathematical model of flow and pollution in saturated aquifers, including the relevant processes and internal relations, and identifies their parameters. Introduction of numerical methods. Uses documented analytical and numerical models for the solution of groundwater flow with solute. Extensive hands-on experience on PC and Workstation.

Modeling Groundwater Movement (GLY 6836) 3 credits
Focuses on hydrogeologic modeling, considers groundwater flow space and time scale, and surface-ground waters interaction. Evaluates methods of analysis for the rainfall-runoff process, evapotranspiration and soil moisture, deep percolation, river-aquifer interaction and flow routing, and catchment basin modeling. Construction of the conceptual groundwater model, defining the mathematical solution, and application of the numerical method of solution. Surveys numerical methods. Overviews the parameter identification. Uses documented numerical models and computer codes for the solution of groundwater problems. Extensive hands-on experience on PC and Workstation.

Methods in Hydrogeology (GLY 6838) 3 credits
Designed to introduce students to practical aspects of hydrogeology, including project design, field methods and data analysis.

Coastal Hazards (GLY 6888) 3 credits
A global review of natural and human-induced hazards as they affect coastal zones, including the identification of site specific and regional coastal hazards. Mitigation and management are related to individual and community hazard perceptions, risk assessment and response. Emphasis is placed on the susceptibility of the SE Florida region to oil (chemical) spills, coastal floods due to extreme events, and to the potential impacts of global sea level rise.

Physical and Geological Oceanography (OCE 6097) 3 credits
Provides an overview of the atmospheric, physical and geological processes that govern our oceans and coastal margins.

Underwater Optical Imaging for Marine Scientists (OCE 6267) 3 credits
This course introduces the key theoretical concepts in underwater optical imaging, the alternate imaging technologies and related data formats and science products. An overview of imaging and visualization using conventional photography and videography leads to more advanced techniques like laser line scan, range-gated line scanning lidiar, fluorescence images and 3D digital plankton imaging systems.

Ocean Monitoring System (OCE 6268) 3 credits
International agreements and conventions call for safety at sea, effective management of the marine environment and sustainable utilization of its resources. This course provides the international framework, concepts and tools used to measure, rapidly detect and provide timely predictions of changes in a broad spectrum of marine phenomena.

Marine Optics (OCE 6269) 3 credits
Marine optics is relevant to a diverse array of marine and environmental science disciplines. The course introduces the theoretical concepts of the irradiative transfer of light through natural waters and how electromagnetic waves interact with natural water and its constituents.

Chemistry Electives

Chemistry for Environmental Scientists (CHS 6611) 3 credits
Course is designed for environmental scientists and requires minimal chemical training (one year of general chemistry with a "C" or better or permission of instructor). Introductory chemical basics are covered to lay a foundation for the remainder of the course. Atmospheric chemistry (global warming, ozone layer) are covered. However, aquatic chemistry and its effects on biotic communities and humans are emphasized.

Kinetics and Energetics of Reactions (CHM 6720) 3 credits
A detailed look at reactions of chemical elements and molecules, their rates and thermodynamics. Chemical kinetics, rate laws, collision theory and transition state theory. Reaction and structural dynamic. Thermochemistry, properties of ideal and non-ideal systems. Chemical equilibria.

Synthesis and Characterization (CHM 6730) 3 credits
Synthetic procedures and methods for preparation of inorganic, organic, and polymeric compounds, with special attention to recent developments. Methods of characterization and identification of chemical compounds, with emphasis on physical methods.

Advanced Biochemistry (BCH 6740) 3 credits
Principles of biomolecular structure determination by spectroscopic methods. Enzyme kinetics.

Transport mechanisms across membranes. Molecular physiology and molecular genetics.

Materials Chemistry (CHM 5716) 3 credits
An introduction to solid-state and inorganic materials chemistry. Preparative techniques and methods of characterization are discussed, particularly X-ray diffraction. Semiconductors, carbon-based electronics, nanomaterials, etc. are discussed in context with their structures and optical, magnetic and conductive properties. A crystallography workshop is included.

Instrumentation (CHM 6157) 3 credits
An overview of modern instrumental techniques used in various areas of chemistry (analysis, characterization, identification). Topics include spectroscopy, chromatography, electrochemistry, theory and applications.

Advanced Organic Chemistry (CHM 6225) 3 credits
Introduction to the concepts of modern physical organic chemistry. Elementary molecular orbital theory and applications. Methods for determining reaction mechanisms. Linear free energy relationships. Solvolysis reactions.

Structural Biochemistry (CHM 6351) 3 credits
Emphasizes a computer-based approach to teaching structural biochemistry. It uses hands-on experience to develop essential skills for understanding the relationships between structure and function of biomolecules. Classes are held in computer labs. State-of-the-art software for visualization, manipulation and simulation is used throughout.

Biology Electives

Marine Conservation Biology (BSC 6316) 3 credits
Marine conservation biology is an emerging discipline that draws together the fundamentals of biology, marine science, conservation and management, ethics and policy. Students gather and integrate information from diverse areas to understand threats to marine biodiversity and use contemporary techniques to address marine conservation problems.

Marine Ecosystem Management (BSC 6317) 3 credits
This is a discussion course that introduces advanced topics on managing marine resources using a broad ecosystem-based approach (marine ecosystem-based management - MEBM).

Introduction to Marine Biotechnology (BSC 6346) 3 credits
Introduces the principles and practices of Marine Biotechnology and its commercial applications: 1) the cultivation and genetic manipulation of marine microorganisms, invertebrates and vertebrates; 2) disease impacts in aquaculture systems; 3) the discovery and production of commercially relevant products; 4) policy related to the commercial development of marine resources.

Marine Global Change (OCE 6019) 3 credits
Introduction to long-term and global scale changes in terrestrial and marine environments and the impact those changes have in marine settings, especially the coastal ocean. Natural and anthropogenic changes are described and compared. Topics include invasions, extinctions, climate change, food web modifications, and freshwater issues in the coastal zone.

Biological and Chemical Oceanography (OCE 6057) 3 credits
Explores major biological and chemical processes within the world's ocean, including estuaries,

continental margins and the open ocean.

Dynamics of Marine Biogeochemical Processes (OCE 6096) 3 credits
An overview of dynamic interactions between physical and biogeochemical processes in coastal and open oceans. The course focuses on nutrient and carbon fluxes and the role of physical dynamics in the marine biogeochemical cycle, productivity and plankton dynamics in coastal and shelf areas.

Conservation Biology (PCB 6045) 3 credits
A study of the principles and practice of conservation biology. Emphasis on the primary threats to biodiversity and the application of contemporary tools to solve conservation problems.

Advanced Ecology (PCB 6046) 3 credits
Provides graduate students with a background in development of ecology as a science and current ecological theory and application of ecology for ecosystem management.

Ecological Modeling (EVR 6070) 3 credits
Overview of modeling and simulation techniques, with particular emphasis on applications in environmental science. Discussion of model formulation and validation, hypothesis testing, non-linear phenomena, and forecasting. Involves programming projects in an appropriate language, such as STELLA.

Physics Electives

Radiation Protection and Safety (RAT 6310) 3 credits
Course provides students with the knowledge and technical background to understand the calculation methodology, compliance with safety standards and use of quantitative risk assessment for radiation protection and safety.

Shielding and Commissioning (RAT 6376) 3 credits
Covers the science of opening a new radiation oncology center. Covers shielding calculations, installing and running the acceptance testing of a linear accelerator, high dose rate brachytherapy afterloader, CT simulator, treatment planning systems, commissioning of the treatment planning systems.

Radiation Physics (RAT 6686) 3 credits
Course covers the basics of ionizing and non-ionizing radiation, atomic and nuclear structure, basic nuclear and atomic physics, radioactive decay, interaction of radiation with matter, radiation detection, and dosimetry.

F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and indicate whether any industry advisory council exists to provide input for curriculum development and student assessment.

The curriculum was developed with the assistance of the Department Advisory Board comprised of 16 industry representatives, 7 of which are from companies and agencies that have an environmental engineering focus as shown in Table VIII-1.

Table VIII-1. 2018-2019 Civil Engineering Department Advisory Council Members Involved in Curriculum Development.

Name	Company Name	Position
Jorge L. Armenteros	Continental Florida Materials	Vice President Cement Sales
Ben H. Chen	Chen and Associates	Founder and Chairman
Donald A. Eckler	*Eckler Engineering*	President
Aneesh Goly	Smart Structures	President
Jeffrey Greenfield	*Broward County*	Project Manager
Edward J. Kent	*Parsons*	Technical Director
Alan Klevens	*Transystems*	Principal & Vice President
Adam Maze	DRMP, Inc.	Leader/Project Manager
Matt Olender	Thornton Tomasetti	Principal and Director
Mark Plass	*Florida Dept. of Transportation*	District IV Traffic Operations
S. S. Rajpathak	SRI Consultants, Inc.	President
Will Suero	HDR	Vice President
Ryan Wheeler	Caulfield & Wheeler, Inc.	Vice President

Among the top "soft skills" requested by employers queried in the curriculum development process include: communication, cooperative/team player, self-motivated, supervision/management, project management, analytical thinking, problem solving, detail-oriented, initiative, and organization. The proposed curriculum will provide critical job placement skill development via the innovative research internship partnership with industry.

G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program. Will the university seek accreditation for the program if it is available? If not, why? Provide a brief timeline for seeking accreditation, if appropriate.

Commission on Colleges of the Southern Association of Colleges and Schools (SACS) is the only accreditation agent for the proposed degree program. In December 2013, it reaffirmed Florida Atlantic University's accreditation for a period of 10 years. The proposed degree program will seek accreditation in 2024.

H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor's or master's programs associated with the proposed program. Are the programs accredited? If not, why?

The accreditation agency for corresponding bachelor's degrees associated with the proposed program is the Accreditation Board for Engineering and Technology (ABET). The College of Engineering and Computer Science offers 8 degree programs (Computer Science, Computer Engineering, Electrical Engineering, Mechanical Engineering, Ocean Engineering, Civil Engineering, Geomatics Engineering and Environmental Engineering). The first 7 of which are ABET accredited. The new B.S. in Environmental Engineering curriculum (Fall 2016) is designed to meet all requirements for accreditation by the Accreditation Board for Engineering and Technology (ABET), as developed for Environmental and Similarly Named Programs by the learned societies of the American Academy of Environmental Engineers and Scientists (AAEES) and its cooperating societies: American Institute of Chemical Engineers (AIChE), American Society of Agricultural and Biological Engineers (ASABE), American Society of Civil Engineers (ASCE), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), American Society of Mechanical Engineers (ASME), Institute of Transportation Engineering (ITE), Intelligent Transportation Systems Society (ITSS), SAE International, and the Society for Mining, Metallurgy, and Exploration (SMME). The program's first 3 graduates were in December 2018, and the initial accreditation on-site visit is scheduled for Fall 2020 with fully retroactive status to include the first graduates. The Request for Evaluation is scheduled for January 2020 with a self-study report due in the summer of 2020.

I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional delivery such as distance or distributed learning, self-paced instruction, or external degree programs). If the proposed delivery system will require specialized services or greater than normal financial support, include projected costs in Table 2 in Appendix A. Provide a narrative describing the feasibility of delivering the proposed program through collaboration with other universities, both public and private. Cite specific queries made of other institutions with respect to shared courses, distance/distributed learning technologies, and joint-use facilities for research or internships.

Program staff and faculty will be headquartered on the Boca Raton campus of FAU, but some of the research laboratories may be located in one of the satellite campuses (SeaTech, Davie, Ft. Lauderdale, Jupiter, Harbor Branch, etc.). Therefore, many of the classes in the program will need to be delivered via eLearning or distance learning formats, and currently all graduate courses offered by the Department of Civil, Environmental & Geomatics Engineering are offered as eLearning or distance learning. This program will have an emphasis on hybrid online content to increase access and allow part-time students and professionals to obtain their degrees while still working. Most of the coursework will have class meeting times scheduled for the evening hours for students who want face-to-face time with faculty, providing working professionals the opportunity to attend classes outside of normal working hours if desired.

Current course offerings are planned hat will use the following possible modes and formats of delivery: live online course content with real time video conferencing interaction and recording capabilities, distance learning formats with asynchronous recording and hybrid online lecture content, fully online courses, classes that meet after working hours or on weekends, laboratory sessions using FAU and/or outside agencies/businesses/industries facilities, and the traditional live course format.

A blended system of delivery modes and formats, each chosen to best fit the pedagogical needs of the particular course and student outcomes will provide convenient access and minimize travel and work disruption for students in the program. The most effective delivery system will undergo

continuous improvement after the needs of the students and the achievement of the student outcomes in each course are assessed by the faculty, students, and industry council.

It is anticipated that most courses will have a substantial online component and many many offered entirely online or mostly online. Courses originating in the Boca campus of FAU can be delivered to other FAU campuses using the University's existing state-of-the-art videoconferencing capabilities already in place.

IX. Faculty Participation

A. Use Table 4 in Appendix A to identify existing and anticipated full-time (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Include (a) faculty code associated with the source of funding for the position; (b) name; (c) highest degree held; (d) academic discipline or specialization; (e) contract status (tenure, tenure-earning, or multi-year annual [MYA]); (f) contract length in months; and (g) percent of annual effort that will be directed toward the proposed program (instruction, advising, supervising internships and practica, and supervising thesis or dissertation hours).

The Department of Civil, Environmental & Geomatics Engineering has 17 faculty currently available for this program. Four more faculty joining in Fall 2019, Fall 2021 and Fall 2023 will be also available for the program. All faculty members teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, board certification, or by education and equivalent design experience. Refer to Table 4 in Appendix A for existing and anticipated full-time (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Also listed in Table 4 are affiliate faculty from College of Science and College of Design and Inquiry. Their roles include, but are not limited to, supervision of Ph.D. dissertations from broader perspectives. Affiliate faculty's CV's are also listed in Appendix E.

B. Use Table 2 in Appendix A to display the costs and associated funding resources for existing and anticipated full-time faculty (as identified in Table 4 in Appendix A). Costs for visiting and adjunct faculty should be included in the category of Other Personnel Services (OPS). Provide a narrative summarizing projected costs and funding sources.

With the recent faculty hires anticipated in environmental and transportation engineering for the 2019-2020 academic year, faculty staffing in the Department is sufficient to initiate the program. The faculty salary and benefits needed to support this program will come entirely from reallocated base E&G funds. For Year 1, the budget includes $265,778 in funds reallocated from the department to fund faculty salaries and benefits for the current faculty members in the program, and the recent new faculty members being hired on vacant lines. The reallocated salaries and benefits extend into the fifth year and include any increases in percent effort for current faculty as well as salaries and benefits for two new faculty members (one starting in Fall 2021 and one starting in 2023), for a total of $436,409 for Year 5. See Table 4 for a complete listing of faculty involved with the program.

C. Provide in the appendices the abbreviated curriculum vitae (CV) for each existing faculty member (do not include information for visiting or adjunct faculty).

See Appendix E for faculty CV's.

D. Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service. Such evidence may include trends over time for average course load, FTE productivity, student HC in major or service courses, degrees granted, external funding attracted, as well as qualitative indicators of excellence.

The Department of Civil, Environmental & Geomatics Engineering is very productive in terms of teaching, research and service. Since its inception in 2001, the undergraduate student body has grown from 6 (Fall 2001) to 416 (Spring 2019, headcounts: Civil – 245, Geomatics – 24, Environmental – 41, Pre-Professional with the designation of Civil, Environmental or Geomatics – 106). There are 45 students currently in the MS program, and 12 Ph.D. students, supervised by CEGE faculty, are registered in the sustainable infrastructure track in the Ph.D. with Major in Ocean Engineering. The Department has produced an average of 54 BS degrees and 11 MS degrees each year for the last five years. The faculty, consisting of 15 full time, delivers 30-32 classes each spring and fall semester.

During the 2018-2019 fiscal year, the faculty wrote 26 research proposals as PIs to federal, state and local funding agencies, with 12 of them being awarded for a total of $2.63 million. The Department houses Freight Mobility Research Institute (FMRI), a US Department of Transportation funded University Transportation Center. FMRI has partnership with Hampton University, Portland State University, Texas A&M University at College Station, University of Florida, University of Memphis and University of Minnesota at Twin Cities. FMRI received an initial funding level f $10.5 million, including matching funds, from US DOT.

The faculty is also very active in university business through various levels of faculty committees. Some are also active in the national committees of professional associations. 70% of faculty served as reviewers for technical journals during the last academic year. Four faculty members received the Engineering Education of the Year awards from the National Council of Engineers since 2014, and one faculty member received the FAU Distinguished Teacher of the Year award in 2014 and FAU Distinguished Mentor of the Year award in 2015; A capstone design project supervised by Drs. Meeroff and Bloetscher received the 1st place award from NCEES $25,000 prize for the Dania Beach LEED Gold Water Treatment Plant Expansion Project; Bloetscher and Meeroff also authored the textbook, "*Practical Concepts for Capstone Design Engineering*," which was adopted by 63 schools worldwide; one faculty member's research on intelligent transportation system was cited in a recent article in Time Magazine.

Due to the interdisciplinary nature of the proposed Ph.D. program, the following postdocs and associate graduate faculty will also provide assistance:

Last Name	**First Name**	**Status**	**Department**
Bullard	Lofton	Associate Graduate Faculty	Engineering & Computer Science
Callaway	Edgar	Associate Graduate Faculty	Electrical Engineering & Computer Science
Challamael	Noel	Associate Graduate Faculty	Ocean and Mechanical Engineering

Last Name	First Name	Status	Department
Dalgleish	Fraser	Associate Graduate Faculty	Ocean and Mechanical Engineering
Goly	Aneesh	Associate Graduate Faculty	Civil, Environmental & Geomatics Engineering
Indeglia	Paul	Associate Graduate Faculty	Civil, Environmental & Geomatics Engineering
Jaramillo	David	Associate Graduate Faculty	Electrical Engineering & Computer Science
Kalish	Kristopher	Associate Graduate Faculty	Electrical Engineering & Computer Science
Liu	Dan	Postdoc	Civil, Environmental & Geomatics Engineering
Liu	Hanlin	Associate Graduate Faculty	Ocean and Mechanical Engineering
Mitrovic	Nikola	Postdoc	Civil, Environmental & Geomatics Engineering
Ouyang	Bing	Associate Graduate Faculty	Ocean and Mechanical Engineering
Romance	Nancy	Associate Graduate Faculty	Electrical Engineering & Computer Science
Saliah-Hassane	Hamadou	Associate Graduate Faculty	Electrical Engineering & Computer Science
Smith	Richard	Associate Graduate Faculty	Ocean and Mechanical Engineering
Yim	Solomon	Associate Graduate Faculty	Ocean and Mechanical Engineering

X. Non-Faculty Resources

A. Describe library resources currently available to implement and/or sustain the proposed program through Year 5. Provide the total number of volumes and serials available in this discipline and related fields. List major journals that are available to the university's students. Include a signed statement from the Library Director that this subsection and subsection B have been reviewed and approved.

The University Libraries include the S.E. Wimberly Library on the Boca Raton campus, collections housed at the Broward County Public Library to serve FAU in downtown Fort Lauderdale, a

shared-use library with Broward College in Davie, a 20,000-square-foot library on the John D. MacArthur campus in Jupiter and a library at Harbor Branch Oceanographic Institute. The Wimberly Library is a 165,000-square-foot building in the heart of the Boca Raton campus that serves over 900,000 visitors annually. It provides faculty and student group study rooms, a graduate study lounge, study carrels, seating for approximately 1,239, an electronic classroom, facilities for individuals with disabilities, an audiovisual media center and a computer lab. In addition to the computers available for use throughout the library, the entire building is equipped for laptop wireless connectivity. Reference assistance is offered in person or by telephone, email, chat or text. Library instruction sessions may be arranged for classes, or for individual students or faculty members. A five-story addition provides students with a 24-hour study location and housing for several special collections. The University Libraries' extensive holdings of approximately 3.7 million items include books, periodicals, government documents, microforms, maps, media and unique special collections in book arts, American Revolutionary War and Civil War documents, print and recorded music, rare books and manuscripts, and archival materials. The libraries also provide a wealth of electronic resources, including more than one million full-text electronic books and over 100,000 full-text electronic journals, plus access to more than 400 proprietary databases. An online catalog of library holdings provides a listing of materials in the FAU Libraries and the other 11 Florida public university libraries. The library pays for student and faculty access to hundreds of databases, many with full-text articles and books, which are available through the Internet both in the library or off-campus using EZproxy. Through memberships in the Southeast Florida Library Information Network (SEFLIN) and the Center for Research Libraries (CRL), the collections of area libraries and the CRL are available to FAU students, faculty and staff. Research materials, both digital and hard copy, not available in the FAU Libraries' collection may be obtained locally, nationally, and globally through interlibrary loan.
For more information, visit library.fau.edu.

The number of related periodicals is 284, including the following titles:

- AACE international transactions
- ACS Applied Materials & Interfaces
- Advanced cement based materials
- Advances in environmental research
- Advances in Structural Engineering
- African Journal of Environmental Science and Technology
- Air Pollution Consultant
- Air, Soil and Water Research
- AMBIO: A Journal of the Human Environment
- Annales des Ponts et Chaussées
- Applied Catalysis B: Environmental
- Applied Materials Today
- Architectural Design
- Architectural History
- Architectural Record
- Architectural Science Review
- Architectural Theory Review
- Archives of Civil & Mechanical Engineering
- Archives of environmental health
- arq: Architectural Research Quarterly
- Atmospheric Pollution Research
- Australian Journal of Civil Engineering

- Australian Journal of Electrical & Electronics Engineering
- Australian Journal of Environmental Management
- Basic and applied ecology
- Biocycle
- Biodegradation
- Bioresource technology
- Building Acoustics
- Building Design
- Buildings & Landscapes: Journal of the Vernacular Architecture Forum
- Bulletin of engineering geology and the environment
- Bulletin of environmental contamination and toxicology
- Business and the Environment
- Cement and concrete research
- Change Over Time
- Chemosphere
- Chemosphere - Global Change Science
- Circuit World
- Circuits and Systems
- Civil Engineering
- Civil Engineering and Environmental Systems
- Civil Engineering Systems
- Clean - Soil, Air, Water
- Climate Policy
- CoDesign
- Compost Science & Utilization
- Computer-aided civil and infrastructure engineering
- Control engineering practice
- Corporate Social Responsibility and Environmental Management
- Critical reviews in environmental science and technology
- Current Opinion in Environmental Science & Health
- Current Opinion in Environmental Sustainability
- Design issues
- Design week
- Dian Li Yu Neng Yuan=Energy and Power Engineering
- disP - The Planning Review
- Distributed Generation & Alternative Energy Journal
- Earthquake engineering and engineering vibration
- Earthquake Engineering and Structural Dynamics
- EC&M Electrical Construction & Maintenance
- Ecological indicators
- Ecotoxicology and environmental safety
- Ecumene
- Electric Machines and Power Systems
- Electric Perspectives
- Electric Power Components & Systems
- Electrical Engineering
- Electrical Engineering in Japan
- Electrical Wholesaling
- Engineering geology

- Engineering structures
- ENR Engineering News-Record
- Environment
- Environment & Urbanization
- Environment and Planning B: Planning and Design
- Environment and Planning B: Urban Analytics and City Science
- Environment international
- Environment Systems & Decisions
- Environment, Development and Sustainability
- Environmental Biology of Fishes
- Environmental Biosafety Research
- Environmental Chemistry Letters
- Environmental Communication
- Environmental Development
- Environmental Forensics
- Environmental Geochemistry and Health
- Environmental hazards
- Environmental History
- Environmental Humanities
- Environmental impact assessment review
- Environmental Innovation and Societal Transitions
- Environmental management
- Environmental Management and Health
- Environmental microbiology
- Environmental Modeling & Assessment
- Environmental monitoring and assessment
- Environmental Politics
- Environmental pollution
- Environmental Practice
- Environmental Progress
- Environmental Progress and Sustainable Energy
- Environmental research
- Environmental research letters
- Environmental science & policy
- Environmental Science & Technology
- Environmental Science & Technology Letters
- Environmental Science and Pollution Research International
- Environmental Science: Water Research & Technology
- Environmental technology
- Environmental Technology Letters
- Environmetrics
- EPA Journal
- Ethics, Policy & Environment
- European Environment
- European Journal of Environmental and Civil Engineering
- European journal of soil biology
- European Transactions on Electrical Power
- Fabrications: The Journal of the Society of Architectural Historians Australia & New Zealand

- Frontiers of Architecture and Civil Engineering in China
- Frontiers of Environmental Science & Engineering in China
- Future Anterior: Journal of Historic Preservation History Theory & Criticism
- Geographical and Environmental Modelling
- Geography and Natural Resources
- Geomechanik und Tunnelbau = Geomechanics And Tunnelling
- Geosystem Engineering
- Gesta
- Global Change Biology
- Global Environmental Change Part B: Environmental Hazards
- Global Environmental Change: Human and Policy Dimensions
- Global environmental politics
- Global Sustainability
- Great Plains Research
- Green Chemistry
- Greener Management International
- Hazardous Waste Consultant
- High Power Laser Science and Engineering
- HKIE Transactions
- Hospitality Design
- ICFAI Journal of Environmental Economics
- IEEJ Transactions on Electrical and Electronic Engineering
- IETE Journal of Research
- IETE Technical Review
- Impact Assessment & Project Appraisal
- Indoor Air
- Integrated Environmental Assessment and Management
- International Construction
- International journal for numerical and analytical methods in geomechanics
- International Journal for Numerical Methods in Biomedical Engineering
- International Journal for the History of Engineering and Technology
- International Journal of Agricultural and Environmental Information Systems (IJAEIS)
- International Journal of Architectural Computing
- International Journal of Architectural Heritage: Conservation, Analysis, and Restoration
- International journal of communication systems
- International Journal of Digital Literacy and Digital Competence (IJDLDC)
- International Journal of Electrical Engineering Education
- International journal of emerging electric power systems
- International Journal of Energy Sector Management
- International Journal of Environmental Health Research
- International Journal of Environmental Studies
- International Journal of Geotechnical Engineering
- International Journal of Information Systems for Crisis Response and Management (IJISCRAM)
- International Journal of Open Source Software and Processes (IJOSSP)
- International Journal of Phytoremediation
- International Journal of Space Structures
- International Journal of Structural Integrity
- International Review for Environmental Strategies

- IOP Conference Series: Materials Science and Engineering
- ISA Transactions
- ISABB Journal of Health and Environmental Sciences
- ITS Journal
- Journal of Aerosol Science
- Journal of Architectural Conservation
- Journal of Architectural Education
- Journal of Architectural Engineering
- Journal of bridge engineering
- Journal of cleaner production
- Journal of Coastal Conservation
- Journal of Cold Regions Engineering
- Journal of composites for construction
- Journal of Construction Engineering and Management
- Journal of Earthquake Engineering
- Journal of Electromagnetic Analysis and Applications
- Journal of electrostatics
- Journal of Energy Engineering
- Journal of Entrepreneurship in Emerging Economies
- Journal of environmental management
- Journal of environmental psychology
- Journal of environmental radioactivity
- Journal of Environmental Science and Health . Part A: Environmental Science and Engineering and Toxicology
- Journal of Environmental Science and Health, Part C: Environmental Carcinogenesis and Ecotoxicology Reviews
- Journal of Environmental Studies and Sciences
- Journal of Environmental Systems
- Journal of Exposure Science and Environmental Epidemiology
- Journal of Flood Risk Management
- Journal of Geotechnical and Geoenvironmental Engineering
- Journal of geotechnical engineering
- Journal of hazardous materials
- Journal of Hazardous, Toxic, and Radioactive Waste
- Journal of Infrastructure Systems
- Journal of intelligent transportation systems
- Journal of Material Cycles and Waste Management
- Journal of Materials Chemistry B: Materials for Biology and Medicine
- Journal of Materials in Civil Engineering
- Journal of Occupational & Environmental Medicine
- Journal of Performance of Constructed Facilities
- Journal of Porous Materials
- Journal of Professional Issues in Engineering Education and Practice
- Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering
- Journal of Sensor Technology
- Journal of Signal Processing Systems
- Journal of soil contamination
- Journal of Structural Engineering
- Journal of Surveying Engineering

- Journal of Technical Writing and Communication
- Journal of terramechanics
- Journal of the Air & Waste Management Association
- Journal of the American Institute of Planners
- Journal of the American Water Works Association
- Journal of the Franklin Institute, of the State of Pennsylvania, for the Promotion of the Mechanic Arts; Devoted to Mechanical and Physical Science, Civil Engineering, the Arts and Manufactures
- Journal of the Illuminating Engineering Society
- Journal of the Society of Architectural Historians
- Journal of Transportation Engineering, A: System
- Journal of Transportation Engineering, Part A: Systems
- Journal of Transportation Engineering, Part B: Pavements
- Journal of Urban Planning and Development
- KSCE Journal of Civil Engineering
- Landscape and urban planning
- Laser & Photonics Reviews
- Lighting Research & Technology
- Local environment
- Low Carbon Economy
- Marine environmental research
- Marine pollution bulletin
- Marine structures
- Monographs of the Western North American Naturalist
- Natural Hazards
- Natural hazards review
- Nature Nanotechnology
- Nature Reviews Materials
- Nexus Network Journal: Architecture & Mathematics
- npj Clean Water
- Occupational Hazards
- Opflow
- Philips Journal of Research
- Photogrammetric record
- Pollution Engineering
- Power engineering
- Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management
- Practice Periodical on Structural Design and Construction
- Protection of Metals and Physical Chemistry of Surfaces
- Regional environmental change
- Remediation : The Journal of Environmental Cleanup Costs, Technologies & Techniques
- Revue Européenne de Génie Civil
- Revue Française de Génie Civil
- Road Materials and Pavement Design
- Russian Electrical Engineering
- Sadhana: Academy Proceedings in Engineering Sciences
- SAH Newsletter
- Science of The Total Environment
- Ship Technology Research (Schiffstechnik)

- Ships and Offshore Structures
- Soil Dynamics and Earthquake Engineering
- Soil Mechanics and Foundation Engineering
- Stahlbau
- Structural Engineering International
- Structural Optimization
- Structural Safety
- Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance
- Subsurface Sensing Technologies and Applications
- Sustainable Cities and Society
- Sustainable Facility
- The Architects' Journal
- The Canadian Architect
- The International Journal of Life Cycle Assessment
- The Journal of Architecture
- The Journal of Computational Multiphase Flows
- The Journal of Environmental Education
- Thin-walled structures
- Transportation Geotechnics
- Transportation Quarterly
- Tunnelling and underground space technology
- Vernacular Architecture
- Virtual and Physical Prototyping
- Waste & Recycling News
- Waste Age
- Waste management
- Waste Management & Research
- Waste News
- Waste360
- Waste360 (Online)
- Water and Environment International
- Water, Air, and Soil Pollution
- Wiley Interdisciplinary Reviews: Energy and Environment
- World Wastes
- 工程热物理学报 = Journal of Engineering Thermophysics
- 环境科学学报英文版 = Journal of Environmental Sciences
- 资源与生态学报英文版 = Journal of Resources and Ecology

29 Databases:

Database	Description
Abstracts in New Technology & Engineering (Proquest)	ANTE is an abstracting and indexing service monitoring publications from the U.K. and the U.S. Coverage includes new technologies such as information technology and computing, electronics, biotechnology, medical technology, as well as engineering (including construction, electrical and chemical engineering) and allied subject areas. Sources covered include periodicals, conference proceedings, technical reports, trade journal/newsletter items, patents, books, and press releases.
Aluminium Industry Abstracts	Provides comprehensive coverage of the world's technical literature on aluminium/aluminum, production processes, products, applications, and business developments.
American Institute of Physics (AIP) Journals	Provides access to full-text physics journal articles.
Applied Science & Technology Source	Includes Applied Science & Technology Full Text, Applied Science & Technology Index Retrospective and additional content. This database offers a diverse array of full-text and indexed content that covers the full spectrum of the applied sciences and computing disciplines from acoustics to aeronautics, and neural networks to nuclear engineering.
Art and Architecture Source	Includes Art Full Text, Art Index Retrospective and additional content. This art research database covers a broad range of subjects from fine, decorative and commercial art, to various areas of architecture and architectural design. It features full-text articles, indexing and abstracts for an array of journals, books and more.
Avery Index to Architectural Periodicals	Covers the current literature of architecture and design, indexing more than 1000 US and foreign journals.
Biotechnology Research Abstracts	This database provides citations and abstracts to research articles on biotechnology (medical, agricultural, and environmental) and bioengineering.
Ceramic Abstracts	Comprehensive database for the ceramics industry. Source materials include over 3000 journals, proceedings, patents, standards and industry literature.
Civil Engineering Abstracts	This link opens in a new window This database provides indexing and abstracts from more than 4,000 current serial and non-serial titles, including content from ASCE and ICE. It covers all civil aspects from architecture, structural design and construction engineering to environmental, seismic engineering and forensics.
Compendex (Engineering Village)	Compendex is the most comprehensive interdisciplinary engineering database in the world. It contains over 8 million records and references over 5,000 international engineering sources including journal, conference, and trade publications.
Copper Technical Reference Library	Provides an online bibliographic database of the world's literature on copper, copper alloys, and copper technology.

Database	Description
Corrosion Abstracts	Corrosion Abstracts provides the world's most complete source of bibliographic information in the area of corrosion science and engineering.
Emerald eJournals Premier	Emerald eJournals Premier provides access to all current content and selected archive material for all Emerald eJournals. Subjects include engineering, computing & technology, and management.
Engineered Materials Abstracts	Begun in 1986, Engineered Materials Abstracts is an electronic database containing Ceramics, Composites and Polymers subfiles. Sources covered include over 3,000 periodicals, conference proceedings, technical reports, trade journal/newsletter items, patents, books, and press releases.
Environmental Engineering Abstracts	Covers the world literature pertaining to technological and engineering aspects of air and water quality, environmental safety, and energy production.
IOPscience	Provides access to scientific, medical and technical journals hosted by IOP (Institute of Physics)
Materials Business File	Materials Business File focuses on industry news, international trade data, government regulations and management issues related to the metals and materials industries.
Materials Science & Engineering Database (Proquest)	The ProQuest Engineering Collection contains engineering related full-text articles, granular access to millions of figures and tables within articles, and the entire range of bibliographic records from the CSA Engineering Research Database, a comprehensive index to world literature on technological and engineering innovations.
MathSciNet (AMS)	MathSciNet (EBSCOhost) |1940-present
Mechanical and Transportation Engineering Abstracts	Provides citations, abstracts, and indexing of the serials literature in mechanical and transportation engineering and their complementary fields, including forensic engineering, management and marketing of engineering services, engineering education, theoretical mechanics and dynamics, and mathematics and computation. This database provides in depth, comprehensive international coverage of engineering literature, monitoring more than 3000 serial titles as well as numerous non-serial publications.
METADEX	A comprehensive source for information on metals and alloys: their properties, manufacturing, applications, and development.
Risk Abstracts	Risk Abstracts encompasses risk arising from industrial, technological, environmental, and other sources, with an emphasis on assessment and management of risk.
SciFinder	Provides comprehensive chemical and related scientific information including journal articles, patents, chemical reactions, and chemical regulatory data.
SciTech Collection (ProQuest)	This collection covers science and technology research, combining full-text journals with detailed indexing of global literature on natural sciences, engineering and technology.

Database	Description
Toxicology Abstracts	Toxicology Abstracts covers issues from social poisons and substance abuse to natural toxins, from legislation and recommended standards to environmental issues.
TOXLINE	Provides access to information in all areas of toxicology, including chemicals and pharmaceuticals, pesticides, environmental pollutants, and mutagens and teratogens.
Web of Science	Three unique citation databases which allow searching cited references as well as traditional searches independently or in combination: Science Citation Index Expanded, Social Sciences Citation Index, and Arts and Humanities Citation Index.

Print volumes:

Subject General	Sub-Categories	Call Number Range	Total Number of Print Volumes
Hydrology, Water		GB651-GB2998	5046
Environmental sciences		GE1-GE350	805
Human ecology, Anthropogeography	Urban geography, rural settlements, settlements by region	GF126-GF900	159
Human ecology, Anthropogeography	Environmental influences on humans, Human influences on the environment, Settlements, Cities, Urban geography	GF51-GF125	228
Environmental management		HD30.255	34
Transportation and communications	Railroads. Rapid transit systems	HE1001-HE5600	324
Transportation and communications	Freight, Passenger traffic, Urban transportation	HE1-HE311	345
Transportation and communications	Traffic engineering, Roads and highways, Streets, Traffic surveys, Bridges, Tunnels, Vehicular tunnels	HE331-HE380	150
Transportation and communications	Water transportation	HE380.8-HE560	74
Transportation and communications	Automotive transportation	HE5601-HE5725	118
Communities. Classes. Races	Human settlements, Communities, Urban groups, The city, Urban sociology, Garden cities, "The city beautiful", City planning, Urban renewal, Urban redevelopment	HT51-HT178	2134

Subject General	Sub-Categories	Call Number Range	Total Number of Print Volumes
Environmental law		KF3775-KF3821	95
Architecture	General, Architecture and the state, History, Architecture as a profession, Study and teaching, Research, General works, Architectural criticism, Architectural drawing and design	NA1-NA4050	2521
Architecture	Special classes of buildings	NA4100-NA8480	820
Architecture	Aesthetics of cities, City planning and beautifying	NA9000-NA9429	323
Landscape architecture		SB469-SB598	98
Engineering, Civil engineering	Engineering instruments, meters, Industrial instrumentation, Human engineering, Systems engineering, Environmental engineering, Engineering design, Engineering economy, Management of engineering works	TA165-TA194	343
Engineering, Civil engineering	Engineering machinery, tools, and implements, Engineering mathematics, Engineering analysis, Mechanics of engineering, Applied mechanics, Acoustics in engineering Acoustical engineering, Materials of engineering and construction, Mechanics of materials, Disasters and engineering, Surveying, Structural engineering, Engineering geology, Rock mechanics, Soil mechanics, Underground construction, Earthwork, Foundations, Tunneling, Tunnels, Transportation engineering	TA213-TA1280	3698

Subject General	Sub-Categories	Call Number Range	Total Number of Print Volumes
Environmental technology, Sanitary engineering	Municipal engineering, Environmental protection, Environmental pollution, Environmental effects of industries and plants, Water supply for domestic and industrial purposes, Water pollution, Water purification. Water treatment and conditioning, Saline water conversion, Water distribution systems, Sewage collection and disposal systems, Sewerage, Municipal refuse, Solid wastes, Special types of environment Including soil pollution, air pollution, noise pollution, Industrial and factory sanitation, Industrial and factory wastes, Hazardous substances and their disposal	TD1-TD1066	1187
Highway engineering. Roads and pavements		TE1-TE450	729
Railway construction		TF200-TF320	16
Bridge engineering		TG1-TG140	25
Building construction	Systems of building construction Including fireproof construction, concrete construction, Details in building design and construction Including walls, roofs, Buildings: Construction with reference to use- Including public buildings, dwellings, Construction by phase of the work, Environmental engineering of buildings, Sanitary engineering of buildings, Plumbing and pipefitting, Heating and ventilation, Air conditioning, Illumination, Lighting,Decoration and decorative furnishings, Protection of buildings	TH1000-TH9745	315
Building construction	Architectural engineering. Structural engineering of buildings	TH845-TH895	37

Subject General	Sub-Categories	Call Number Range	Total Number of Print Volumes
Total			19624

And two print journal subscriptions:

- Florida Scientist
- Scientific American

Describe additional library resources that are needed to implement and/or sustain the program through Year 5. Include projected costs of additional library resources in Table 2 in Appendix A. Please include the signature of the Library Director in Appendix B.

No additional library resources are anticipated.

B. Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.

Instructional and Classroom Support:

Classrooms: FAU has 371 instructional venues across its seven campuses, with 110 designated as "general classroom" and 210 as "class lab" usage. OIT provides the infrastructure, instructional technology, and AV support for 82 percent of those rooms. Of the OIT-supported classrooms, 100 percent now have presentation ability, which includes a computer, projector, DVD player, Sympodium (which serves as computer monitor and electronic whiteboard), and document camera, as well as the ability to connect a laptop and use it as the presentation medium. Over 96 percent of the centrally scheduled (some college-managed) classrooms are equipped with presentation capability. OIT has AV technicians on staff whenever classes are in session, including evenings and Saturdays. These staff members can assist faculty and presenters with learning to use the equipment and provide troubleshooting in the event of a technical problem. Of FAU's 370 classrooms, 23 have the lecture-capture capability, and 31 of those rooms can also provide live video conferencing for classes as well as thesis and dissertation presentations and other events.

Instructional and Open Computer Labs: FAU has nineteen open labs (Boca Raton: twelve; Fort Lauderdale: one; Davie: three; Jupiter: three) and twenty-five instructional labs (Boca Raton: seven; Fort Lauderdale: nine; Davie: six; Jupiter: three). In addition, the Department's students have access to a large computer lab in the library (IS113) and 24-hr card access to labs in buildings 4 and 96. OIT provides support and management for all general instructional and open computer labs on all FAU campuses. This provides students with a high level of uniformity across all campuses. Computers in campus labs have a consistent look and feel, a uniform set of software packages, and access to the printers. Instructional labs provide a teaching console with a computer and projector and computers for each student. Specifications and capabilities in each lab are listed on the OIT Website. The computer center's open laboratory is open from 8:00 a.m. - 10:00 p.m. seven days per week. All computer laboratories in the residence halls, the student apartments, and the Student Union are open twenty-four hours seven days per week.

Virtual Computer Labs: FAU also has virtual computing labs, which will allow students anywhere

to connect to a virtual computer and launch applications licensed by FAU via VMWare. Current licensed applications include Microsoft Office, Minitab, SPSS, Visual Studio, Notepad, and essentially all software programs necessary for required coursework such as AutoCAD, Revit, EPANet, etc. Applications will be added to the suite as necessary. This project is vital for supporting distance learning students, who require access to discipline-specific applications that are currently available in the physical computing labs.

Training: OIT's Instructional Technologies division offers training for the multitude of services OIT provides. Training is available for faculty, staff, and students in the effective use of technology through free instructor-led courses on Google Applications for Education (documents, presentations, spreadsheets, forms, websites, groups, calendar and Google+). In-person training for learning management systems (LMS) and classroom technology are limited to faculty and graduate teaching assistants. These classes are taught in a computer lab with a hands-on approach. A schedule of the computer training courses is posted on the OIT Website and is published in the weekly University announcements. Computer training courses are offered at the Boca Raton campus and FAU's partner campuses, including Davie, Fort Lauderdale, and Jupiter. In 2018, over 700 training sessions took place, including 460 software application-related workshops and 273 LMS sessions. To enable students to complete necessary course tasks, all students have access to online LMS tutorials. OIT also provides special courses for departments or other groups and one-on-one sessions on request. These special courses include classes on the use of Word for graduate students who are working on theses and dissertations, orientation on the use of eClassroom/videoconference technologies, and training on the University's Web content management system, OmniUpdate. In addition to designing and delivering training, OIT staff members develop documentation and tutorials including online training videos. Upcoming online training tutorials will feature topics such as an Introduction to eClassrooms, Teaching via Videoconference, and Using Personal Lecture Capture Tools. OIT also makes Microsoft IT Academy online training available to faculty and staff upon request. OIT participates in the annual New Faculty Orientation by providing information about technology support, resources, and services available to faculty at FAU. In addition to centralized training in technology through OIT, FAU's colleges have courses dedicated to helping students become comfortable working with technology.

Video Production and Event Support: OIT provides faculty the opportunity to video record lecture snippets or demonstrations that can be used for classes. It also records and/or Webcasts academic presentations, invited speakers, key meetings (e.g., the search and interview of candidates for FAU president, and the State of the University Address), commencement, and other ceremonies using a variety of platforms.

Applications: FAU licenses the learning management system for University use. FAU also licenses access to Respondus StudyMate, Respondus LockDown Browser, SafeAssign, TurnItIn, iTunes U, and lecture capture via Mediasite. Lecture videos are available via the learning management system in various formats to accommodate an array of connection speeds. The full list of software available for college and department purchase for on-site use is available online.

College Computing Facilities

(Mahesh Neelakanta, Director, Technical Services Group, http://tsg.eng.fau.edu/)

The Technical Services Group is responsible for the computer laboratories and computer support in the College of Engineering and Computer Science. The following laboratories are available in the College (Engineering East Building 96, Engineering West Building 36):

College Open Use Labs:

EW 130 - Mechanical Engineering Open Lab (20 Computers)
EE 207 - Engineering Open Use Computing & Teaching Lab (30 Computers, 60 Seats)
EE 213 - Engineering Open Use Computing & Teaching Lab (18 Computers, 36 Seats)

College Research, Teaching & Computer Labs:
Engineering West Building 36 Labs:
EG 132 - Experimental Methodology Lab

Instructional Services Building 4 Labs:
IS 101 - CITSS Transportation Lab
IS 103 – Bloetscher/Meeroff Capstone Design Lab
IS 113 – Computer Aided Design Lab

Engineering East Building 96 Labs:
EE 203 - Microprocessor, Logic Design, Microcontroller Lab
EE 205A - Engineering Student Work Lab
EE 208 - Senior Projects, Design I and II Lab
EE 209 - Controls & Communications Lab
EE 212 - Innovation Lab
EE 408A - Apple Lab
EE 408B - Signal Image & Video Processing Lab
EE 409 - Multipurpose Lab (CSI)
EE 410A - Web Development Lab
EE 410B - Digital Signal Processing Lab
EE 413 - Mobile Computing, Sensor and Wireless Lab
EE 507A - Empirical Software Engineering Lab (ESEL)
EE 507B - BioInformatics Lab
EE 508 - RF, Microwave & Satellite Communications Lab

Department teaching laboratory, research laboratory, and office space: The Florida Atlantic University Department of Civil, Environmental & Geomatics Engineering has several instructional laboratories and research laboratories occupying 9,231 ft² of space. Table X-1 lists all laboratories used by environmental engineering students, their location and floor space.

Table X-1. Environmental Engineering Teaching/Research Laboratories

LABORATORY NAME	ROOM #	Teaching (T), Research (R)	AREA (ft²)
Environmental Engineering Process Laboratory	EG-152C	R	303
Environmental Engineering Research Laboratory	EG-154	R	253
Environmental Photochemistry Research Laboratory	EG-153	R	82
Nutrient Analysis Research Laboratory	EG-150	R	79
AutoCAD Laboratory	IS-113	T	1,800
Civil, Environmental & Geomatics Engineering Design Laboratory	IS-103	T	869
Hydrosystems Research Laboratory	EG-229	R	133

Environmental Nanotechnology Laboratory	BS-504	R	662
Environmental Chemistry Teaching Laboratory	EG-263	T	1,202
Hydrodynamics Laboratory [Ocean Engineering]	EG-157	T	1,522
Total			**6,905**

Additional details on the current status of the facilities summarized in Table 14 are described as follows:

Environmental Engineering Process Laboratory, **EG-152C**. This laboratory was renovated in 2015 and is the unifying place to achieve departmental goals of educating competent, licensed professional engineers responsible for the sustainability of the environment. The major renovation added a walk-in temperature controlled room and a much needed separation from the Materials and Structures lab space in EG152B, which is now closed off with a 10-ft wall and drop ceiling. This space is equipped to allow students to fully experience the state-of-art capabilities of environmental instrumentation and acquire needed knowledge in water purification and mitigating environmental disasters.

Environmental Engineering Research Lab, EG-154. The laboratory fosters thesis-based research training to produce the next generation of engineering educators and researchers, a national priority. Its mission is to provide access to scientific and analytical equipment for research and training of civil engineers in the environmental disciplines who are interested in improving the quality of life through sustainability and protection of our environment and natural resources. This means the development of sufficient clean water supplies; the prevention of river, lake, ocean, and groundwater pollution; the maintenance of air quality; the remediation of land and water bodies contaminated with hazardous chemicals; and working with our local industry partners to provide solutions to their technological needs.

Environmental Photochemistry Research Lab, EG-153. This lab houses the photocatalytic oxidation chamber and the provisionally-patented photochemical iron-mediated aeration technologies that FAU has pioneered for detoxifying waste. Students can push the boundaries of water and wastewater treatment using advanced oxidation processes.

Nutrient Analysis Research Lab, EG-150. This lab is home to FAU's total organic carbon and total nitrogen analyzer as well as solids testing systems. With these facilities, students can explore the nature of nutrient pollution in the environment to better protect our oceans, our coastal zone, our water supplies, and our Everglades.

AutoCAD Laboratory, IS-113. Central to engineering education, the AutoCAD Laboratory is constantly upgraded with the latest computer technology, processor speed, and cloud-based sharing of sophisticated 2-D and 3-D design and analysis software for computer-aided design, building information modeling, cost estimation, water resource modeling, and hydraulic simulations with an adjoining printing/plotting area.

Civil, Environmental & Geomatics Engineering Design Laboratory, IS-103. This lab features a private student team planning/meeting space designed to foster students' presentations and team collaboration. There is a state-of-the-art wireless overhead high-definition projection system with projection screen and an automatic high-definition tracking camera to allow students to record

presentations.

Hydrosystems Lab, EG-229. This lab supports simulation and modeling capabilities essential for hydrological, climate variability and climate change studies. It houses several stand-alone machines along with different computational environments accessing cluster computing resources with large RAM and specialized servers. A number of hydrological modeling software, GIS, and several others dealing with hydro-meteorology (precipitation data processing, infilling, radar-based precipitation analysis) software developed at FAU are also available on several computational platforms. A variety of software dealing with optimization and artificial neural networks, data mining and statistical analysis are also available. Computationally intensive tasks that handle large data sets in space and time and processing capabilities to handle geospatial analysis and geostatistics are also available for hydrologic simulation and water resources management studies.

Environmental Nanotechnology Laboratory, BS-504. Established in 2015, this lab is equipped for investigating environmental nanotechnology and its interactions with environmental chemistry, with research instruments such as dynamic light scattering, zeta potential analyzer, quartz crystal microbalance, UV-vis spectrometer, and gas chromatograph. The research conducted in the lab focuses on interactions of nanoparticles with environmental and biological surfaces and application of nanotechnology in water treatment, environmental remediation, and renewable energy.

Environmental Chemistry Laboratory, EG-263. In 2010, the College of Engineering and Computer Science funded construction of the Environmental Chemistry Laboratory in a space previously serving mechanical engineering graduate students. The laboratory contains a teaching station computer with SmartBoard technology that projects to two plasma TV screens. Directly across is an L-shaped teaching assistant prep area equipped with laboratory dishwasher, distilled water machine, dual sinks, goggle sterilizing cabinet, dry stock storage, lab refrigerator/freezer, and eyewash/safety shower station. Across the entrance is a flammable cabinet next to the spill kit containment area, a standing 20°C BOD incubator, and storage cabinet. There is 6-ft fume hood with explosion-proof flammables and corrosives storage underneath. The hood is equipped with water supply. There are four stainless steel sinks and five rows of bench stations for students. Along the back wall is where the incubators, drying oven, biosafety cabinet,and autoclave sterilizer are located. The current laboratory is adequate for current and projected instructional and undergraduate teaching/research needs for the near future. Previous needs with respect to additional rapid response pH meters, optical dissolved oxygen probes, and an additional spectrophotometer were addressed in 2014. The HVAC system was completely upgraded in 2018-2019.

Hydrodynamics Laboratory, EG-157. The Hydrodynamics Laboratory supports the needs of the Department of Civil, Environmental and Geomatics Engineering and the Department of Ocean and Mechanical Engineering. The laboratory is located in EG157 and occupies approximately 1522 ft^2. There is a single door exit and a rolling shutter exit to the outside of the building and double door exit to the inside of the building. There is a sink in the room. There is also a 30-ft × 17-ft loft at the second floor level with access through a spiral staircase. The room has 24-ft of counter space (on top of cabinets and drawers). The laboratory is equipped with two 3-ft × 6-ft storage cabinets. There is access from the laboratory to the wind tunnel housed at the back of the room. The lab houses a state-of-the-art hydraulic bench, wave tank, open channel flow apparatus, wind tunnel, and fluid mechanics experiments. The fluid hydraulics bench demonstration unit was replaced in 2014, which was the most needed item to properly deliver the student outcomes in the CWR 3201C Applied Hydraulics course. The following additions to the laboratory would enhance student

learning of basic concepts in the near term:

- Flow Over Weir/Notch Apparatus
- Head Loss Measurement of Pipe System
- Pipe Friction Test
- Reynolds Number Experiment Apparatus
- Pelton Turbine Model
- Validation Model of the Bernoulli Equation

C. Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5. Include any projected Instruction and Research (I&R) costs of additional space in Table 2 in Appendix A. Do not include costs for new construction because that information should be provided in response to X (E) below.

The current classroom, teaching laboratory, research laboratory, office, and other space are adequate for implementing and/or maintaining the proposed program through Year 5.

D. If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list. Table 2 in Appendix A includes only Instruction and Research (I&R) costs. If non-I&R costs, such as indirect costs affecting libraries and student services, are expected to increase as a result of the program, describe and estimate those expenses in narrative form below. It is expected that high enrollment programs in particular would necessitate increased costs in non-I&R activities.

No new capital expenditure is anticipated. Additional resources, described in Table 4, are needed to support program faculty (and startup funds and office setup funds), staff, travel, office equipment and supplies, promotional and advertising efforts, and specialized laboratory and instructional equipment and software.

E. Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.

Existing College staff and resources are available which currently provides strong support for the Environmental Engineering Bachelor's degree program. This support includes:

- Computer technician services through the Technical Services Group (TSG)
- Promotional and advertising support through the College Development
- Assistance with Development and Fundraising activities
- Assistance from the Division of Engineering Student Services and Advising with student recruitment and retention, student counseling and petitions, scholarships, and program K-14 outreach activities
- Assistance from the Division of Engineering Student Services and Advising with career development, undergraduate research opportunities, business and industry relations, co-op and internship activities, and placement upon graduation
- Financial management and accounting services
- Other academic, research, personnel, and community outreach services

Financial support will come from a variety of sources, including:

- Florida Atlantic University. The Office of the Provost has committed the continuing funding required for faculty and staff salaries and benefits, as well as for some operational expenses.
- College Carry-Forward Monies. The College has Carry-Forward monies that will be used for the purchase of instructional equipment and other appropriate program needs.
- Donations from Business and Industry. The Environmental Engineering program is generating unprecedented offers of help and financial support.
- Private Contributions. Once the program has been approved, an extensive program of development and fundraising for support of the program will be implemented. Some private contributions for program support are already in the works.
- Contributions in Kind. There are endless opportunities for business and industry to support the program through in-kind contributions. Possibilities include use of equipment and/or facilities; provision of speakers and student mentors; the contribution of design problems; provision of summer employment and consulting opportunities for faculty; internships, part-time employment, and scholarships for students; etc.

The following tables (Table X-2, Table X-3, and Table X-4) include lists of equipment available to deliver the student outcomes of the proposed environmental engineering degree program.

Table X-2. Environmental Engineering Laboratory Existing Equipment

Equipment	Quantity
Bench space, total	40 ft^2
Glassware cabinets	3
Fume hoods, 4 ft × 3.2 ft	3
Custom Bioassay System	1
Biosafety Cabinet, Labconco Purifier Delta Class II, Type A2	1
Chemical Oxygen Demand Heating Block	2
Chromatographic Ion analyzer, Waters	1
Compact Autoclave Sterilizer, NAPCO Model 9000D	1
Composite Sampler, Masterflex E/S	1
Digital Incubator, VWR Model 1525	2
Digital Incubator, VWR Model 1545	1
Digital Mass Balances	2
DR5000 Digital UV-Vis Spectrophotometer	1
Drying Oven, VWR Model 135FM Horizontal Air-Flow	1
Drying Oven, Cole Parmer	1
Filtration Apparatus (vacuum pump, filter holders, manifold)	1
Fluorometer, Ocean Optics	1
High Performance Liquid Chromatography Unit (Waters Breeze System)	1
IDEXX Colilert and Enterolert Quantitation System	1
Ion Specific Probes (nitrate, ammonia, sodium, fluoride)	4
Ion Specific Meters	2
Jar Testing System	1
Koch Membrane Demofilter Unit	1
Large Scale Autoclave Sterilizer	1
Landtec GEM5000+ Air Analyzer	1
Muffle Furnace, Barnstead Type 1400	1
Photoreactor (safety cabinet, microscale reactor, pilot unit; 5-,15-,550-W lamps)	1
Falling Film Pilot Plant Photocatalytic Reactor	1
Portable Turbidity Meters	2

Refrigerated Centrifuge	1
Refrigerator/Freezer	4
Research Vessel, "Minnow", 9.4 ft WaterTender	1
Reverse Osmosis pilot plant	1
Total Organic Carbon Analyzer (Teledyne Tekmar, Apollo unit, with Total Nitrogen, Soil Sampler)	1
Water Purification (Barnstead Diamond UV system, replacement cartridges)	1
Portable Weather Station	3
VWR Circulating Chiller	1
VWR Circulating Water Bath	1
Membrane Skid for RO applications	1
YSI 556 MPS Portable Meter	2
YSI 9000 Photometer	1

Table X-3. Engineering Chemistry Laboratory Existing Equipment

Equipment	Quantity
Compound microscope with a camera attachment	1
BOD Incubator	2
Autoclave Sterilizer	1
Glassware cabinets	3
Fume hood, 6 ft × 3.2 ft	1
Magnetic Stirrer/Hotplate	6
Microbalances	3
DR4000 UV/Vis Spectrophotometer	1
Laboratory Refrigerator/Freezer	1
Distilled Water Machine	1
Ultrasonic Cleaner	1
Gas Law Apparatus Kit	6
BOD Intellical Probe and meter	3
Carbon dioxide vent probe kit	2
Digital barometer	1
Meter docking station	5
pH probe for HqD meter	2
pH probe for sension2	2
Portable spec meter	1
Molecular model kits	10
sensION2 pH/ISE meter	1
Variable pipetters	18
Turbidometer	2
Dessicator cabinets	2
Biosafety Cabinet, Labconco Purifier Delta Class II, Type A2	1
High capacity drying oven	1
High capacity incubator	1
Filtration Apparatus (vacuum pump, filter holders, manifold)	1
Hach Sension3 pH meters	5
Hach Digital Titrator Field Kits	5
Milton Roy Spectronic 601	1
Spectronic 20, Bausch & Lomb	1
YSI 5010 BOD Probe	1

Equipment	Quantity
YSI 5100 DO Meter	5
Vortex Mixers	3
UV Viewing Cabinets	3

Table X-4. Hydrodynamics Laboratory Existing Equipment

Equipment	Quantity
Wind Tunnel (Aerolab 28″x 40″) open circuit low-turbulence wind tunnel	1
Falling Ball Viscometers	5
Fluid Circuit System (for pipe flow experiments) replaced in fall 2014 by a Computer Controlled Fluid Friction in Pipes Unit with Hydraulics Bench with SCADA	1
Scaled Model for Spillway	1
Inclined Manometer	1
Pitot tube	2
U-tube Manometer	1
Large Wave Tank	1
Small Wave Tank	1
Sting Balance (for wind tunnel)	1
Hydrometers	4
Orifice Meter (fluid circuit system)	1
Venturi Meter (fluid circuit system)	1
PIV system (for 3D Stereoscopic particle velocity measurements)	1
Equipment for fluid property measurements	Several
Weighing Scales	5
Software	
HEC-HMS from USACE	30 computers
HEC-RAS from USACE	30 computers
EPANET from EPA	30 computers

F. Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5. Include projected costs of additional equipment in Table 2 in Appendix A.

In terms of additional specialized equipment needed to sustain the program during its growth in the first five years, the main component will involve expanding existing capabilities up to 8 teaching stations for class experiments involving solids filtration, water and wastewater treatment principles, greenhouse effect, mass balance/dilutions, and subsurface contamination as well as creating a new air pollution laboratory. The air pollution lab will need to have instruments for organic and inorganic contaminant characterization, a GC/MS (gas chromatography/mass spectrometry) instrument station for organic contaminants in water and air and soil, an ICP/MS (inductively coupled plasma/mass spectrometry) instrument for trace metals contaminants in water, air, and soil matrices, a meteorological station; clean room; air sampling equipment, gas monitoring equipment, handheld FID/PID, electronic nose, mercury meter, air velocity monitor, calibration gases, air quality meters for particle measurement, ammonia, hydrogen sulfide, carbon monoxide, carbon dioxide, methane, VOCs, etc. A major renovation in 2014-2015 involving EG152C, EG150, EG153, and EG154 added a walk-in temperature controlled room, expanded nutrient analysis facilities, and a much needed separation from the Materials and Structures lab space for EG152C, which was closed off with a 10-ft wall and drop ceiling. A second major renovation project in the same building upgraded the HVAC systems in 2018-2019.

The current Hydrosystems Research Laboratory is adequate for current instructional and research needs. However, only two workstations can fit in the space, so as demand dictates, more space and additional workstations and software licenses may need to be obtained.

The Engineering Chemistry Laboratory is adequate for current instructional and research needs. Previous needs with respect to additional rapid response pH meters, optical dissolved oxygen probes, and an additional spectrophotometer were addressed in 2014.

The shared Hydrodynamics Laboratory space and equipment are barely adequate for current instructional needs. The fluid hydraulics bench demonstration unit was replaced in 2014, which was the most needed item to properly deliver the student outcomes. The following additions to the laboratory would enhance student learning of basic concepts:

- Flow Over Weir/Notch Apparatus
- Head Loss Measurement of Pipe System
- Pipe Friction Test
- Reynolds Number Experiment Apparatus
- Pelton Turbine Model
- Validation Model of Bernoulli Equation

The Environmental Nanotechnology Laboratory is currently being stocked in part with Dr. Yi's startup funds.

To cope with rapid growth in enrollment, a coordinated plan is necessary for meeting the future laboratory needs of the environmental engineering program. A dedicated line of funding for equipment is unlikely in the near future. In the past, the College has been able to set aside varying amounts for equipment purchase and minor renovations for civil engineering laboratories based on prioritized lists of essential items. However, it is difficult to plan for equipment acquisitions when available funds range from very little to several tens of thousands of dollars and may appear on short notice. The faculty and industry council have identified resource development as a top priority in all their recently held bi-annual meetings. Plans are in motion spearheaded by the DAC and Department leadership team ($450K campaign) to solicit laboratory naming sponsorships to assist with equipment acquisition and repair budgets. We expect to develop a cohesive resource development plan that, among other considerations, will include a mechanism for expanding and maintaining our laboratory facilities and equipment in a logical, prioritized manner.

Additional transportation and environmental engineering labs and office space are at Davie and SeaTech campuses.

G. Describe any additional special categories of resources needed to implement the program through Year 5 (access to proprietary research facilities, specialized services, extended travel, etc.). Include projected costs of special resources in Table 2 in Appendix A.

There will be no additional resources needed to implement the program through Year 5.

H. Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5. Include the projected costs in Table 2 in Appendix A.

The Department currently supports 14 graduate assistantships for full-time students. It has a history of supporting graduate research assistantships (GRA) through research contracts and grants. Funding for four additional GRA's positions would come from sponsored research in Year 1 ($68,000). By Year 5, ten more GRA's compared to the current level will be supported by sponsored research based on the projected full-time enrollment ($170,000).

I. Describe currently available sites for internship and practicum experiences, if appropriate to the program. Describe plans to seek additional sites in Years 1 through 5.

The College of Engineering and Computer Science strongly advocates professional work experience for all of its students prior to graduation. Many students in the College accomplish this by working part time or full time during their studies. Others accomplish this goal by internships, many of which are made through the College's extensive database of over 500 companies that offer internship opportunities and regularly hire FAU graduates. The Division of Engineering Student Services assists students in identifying internships opportunities and works closely with the FAU Career Development Center. A team member from the Career Development Center is embedded in the Division and is charged with constantly maintaining and expanding the list of available internships through a portal known as Handshake. An existing course (EGN5940 – Graduate Internship 1-3 credits) is available for this purpose.

Starting with the current Department Advisory Board for the Department of Civil, Environmental & Geomatics Engineering, members with ties to the transportation and environmental engineering fields will be approached to identify opportunities within their firms and sphere of influence. After year one, a program-specific industry advisory council will be formed and will have one of its three standing subcommittees to focus on developing internships opportunities. A tracking system will be put in place to monitor success and student outcomes for continuous improvement purposes, and the program will be assessed annually.

This academic program takes advantage of a unique curriculum to reduce time to degree completion, increase completion rates, and make better use of limited funding by aligning doctoral research with student career opportunities and on-the-job training. It relies on strong partnerships among the university, government entities, industry and the agencies that hire doctoral graduates. Streamlining the pipeline to graduation will improve research productivity and build the talent needed to sustain innovation in the public and private sector to bring about economic prosperity, public health and national security (National Research Council, 2012). Furthermore, if trainees are directly working with employers (businesses, government agencies, nonprofits, etc.) that hire graduates from doctoral programs, those entities can engage with the research institution to provide internships, student projects, mentoring, Ph.D. committee advising with a courtesy graduate appointment, joint authorship on publications, and real-time, hands-on, job training opportunities that lead to full time employment after graduation as well as long lasting research collaborations between academia and industry.

It is a unique feature of this doctoral degree program that dissertation committees consist of academic and qualified industry co-supervisors. Unlike conventional graduate programs, the industry dissertation co-supervisors are directly involved in curriculum development and guided off-campus internships designed to develop technical, entrepreneurial, and executive leadership skills directly leading to industry sponsored post-doctoral employment opportunities. The student interns spend a significant amount of their residency working directly at the industry/government partner site. As a result, students are able to not only pursue high-level academic research, but also potentially join the workforce immediately upon graduation or sooner.

Florida Atlantic University's recent NRT-HDR proposal entitled: "Towards a Data-Driven Nation: Investigative Development of Interdisciplinary Data Science and Engineering" was used to develop the first doctoral internship relationships with industry. The NSF Research Traineeship (NRT) program is designed to encourage implementation of a bold, potentially transformative STEM graduate education training model. FAU proposes to enlist partner agencies in the community that potentially hire graduates from research-based master's and doctoral degree programs to help shape the direction of the research applications. As part of the program, a research trainee internship was developed in which graduate student interns will obtain the skills, knowledge, and competencies needed to pursue a range of STEM careers in the agencies that hire graduates with advanced degrees in engineering. FAU has put together a consortium of strategic collaborations with the private sector, government agencies, federal laboratories, and academic partners to provide this special opportunity for their graduate students.

Currently established internship programs and partnerships in development include the following agencies (letters of support are found in Appendix C):

- National Oceanic and Atmospheric Administration (NOAA)
- Florida Department of Transportation
- Florida Department of Environmental Protection
- Florida Department of Health
- FEMA
- Fermilab
- USGS
- US Coast Guard
- FPL
- US Fish and Wildlife
- Centers for Disease Control
- Geosyntec Consultants
- Water Management Districts

APPENDIX A

TABLE 1-B
PROJECTED HEADCOUNT FROM POTENTIAL SOURCES
(Graduate Degree Program)

Source of Students (Non-duplicated headcount in any given year)*	Year 1		Year 2		Year 3		Year 4		Year 5	
	HC	FTE	HC	FTE	HC	FTE	HC	FTE	HC	FTE
Individuals drawn from agencies/industries in your service area (e.g., older returning students)	3	1	3	1	3	1	3	1	3	1
Students who transfer from other graduate programs within the university**	7	6	0	0	0	0	0	0	0	0
Individuals who have recently graduated from preceding degree programs at this university	2	1	2	1	3	2	3	2	4	2
Individuals who graduated from preceding degree programs at other Florida public universities	0	0	0	0	0	0	0	0	0	0
Individuals who graduated from preceding degree programs at non-public Florida institutions	0	0	0	0	0	0	0	0	0	0
Additional in-state residents***	0	0	0	0	0	0	0	0	0	0
Additional out-of-state residents***	0	0	0	0	1	1	1	1	2	2
Additional foreign residents***	2	2	3	3	3	3	4	4	4	4
Headcount of contitued enrollments from the previous year	0	0	10	8	13	10	18	14	22	17
Totals	**14**	**10**	**18**	**13**	**23**	**17**	**29**	**22**	**35**	**26**

* List projected annual headcount of students enrolled in the degree program. List projected yearly cumulative ENROLLMENTS instead of admissions.
** If numbers appear in this category, they should go DOWN in later years.
*** Do not include individuals counted in any PRIOR category in a given COLUMN.

TABLE 2
PROJECTED COSTS AND FUNDING SOURCES

Instruction & Research Costs (non-cumulative)	Year 1								Year 5						
	Funding Source								Funding Source						
	Reallocated Base* (E&G)	Enrollment Growth (E&G)	New Recurring (E&G)	New Non-Recurring (E&G)	Contracts & Grants (C&G)	Philanthropy Endowments	Enterprise Auxiliary Funds	Subtotal coulumns 1+...+7	Continuing Base** (E&G)	New Enrollment Growth (E&G)	Other*** (E&G)	Contracts & Grants (C&G)	Philanthropy Endowments	Enterprise Auxiliary Funds	Subtotal coulumns 9+...+ 14
Columns	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Faculty Salaries and Benefits	130,681	0	0	0	0	0	0	**$130,681**	298,578	0	0	0	0	0	**$298,578**
A & P Salaries and Benefits	19,635	0	0	0	0	0	0	**$19,635**	35,342	0	0	0	0	0	**$35,342**
USPS Salaries and Benefits	0	0	0	0	0	0	0	**$0**	0	0	0	0	0	0	**$0**
Other Personal Services	0	0	0	0	0	0	0	**$0**	0	0	0	0	0	0	**$0**
Assistantships & Fellowships	68,000	0	0	0	68,000	0	0	**$136,000**	170,000	0	0	170,000	0	0	**$340,000**
Library	0	0	0	0	0	0	0	**$0**	0	0	0	0	0	0	**$0**
Expenses	7,600	0	0	0	0	0	0	**$7,600**	12,450	0	0	0	0	0	**$12,450**
Operating Capital Outlay	0	0	0	0	0	0	0	**$0**	0	0	0	0	0	0	**$0**
Special Categories	0	0	0	0	0	0	0	**$0**	0	0	0	0	0	0	**$0**
Total Costs	**$225,916**	**$0**	**$0**	**$0**	**$68,000**	$0	**$0**	**$293,916**	**$516,370**	**$0**	**$0**	**$170,000**	$0	**$0**	**$686,370**

*Identify reallocation sources in Table 3.
**Includes recurring E&G funded costs ("reallocated base," "enrollment growth," and "new recurring") from Years 1-4 that continue into Year 5.
***Identify if non-recurring.

Faculty and Staff Summary

Total Positions	Year 1	Year 5
Faculty (person-years)	0.69	1.44
A & P (FTE)	0.25	0.45
USPS (FTE)	0	0

Calculated Cost per Student FTE

	Year 1	Year 5
Total E&G Funding	$225,916	$516,370
Annual Student FTE	10	26
E&G Cost per FTE	$22,592	$19,860

TABLE 3
ANTICIPATED REALLOCATION OF EDUCATION & GENERAL FUNDS*

Program and/or E&G account from which current funds will be reallocated during Year 1	Base before reallocation	Amount to be reallocated	Base after reallocation
TAG000277 Civil Engineering	2,432,893	225,916	**$2,206,977**
Totals	$2,432,893	$225,916	**$2,206,977**

TABLE 4
ANTICIPATED FACULTY PARTICIPATION

Faculty Code	Faculty Name or "New Hire" Highest Degree Held Academic Discipline or Speciality	Rank	Contract Status	Initial Date for Participation in Program	Mos. Contract Year 1	FTE Year 1	% Effort for Prg. Year 1	PY Year 1	Mos. Contract Year 5	FTE Year 5	% Effort for Prg. Year 5	PY Year 5
A	Madasamy Arockiasamy, Ph.D. Structural Engineering	Professor	T	Fall 2020	9	0.75	0.05	0.04	9	0.75	0.15	0.11
A	Fred Bloetscher, Ph.D. Environmental & Water Resources	Professor	T	Fall 2020	10	0.83	0.02	0.02	10	0.83	0.05	0.04
A	Jinwoo Jang, Ph.D. Structural Engineering	Assistant Prof.	TE	Fall 2020	9	0.75	0.02	0.02	9	0.75	0.05	0.04
A	Evangelos Kaisar, Ph.D. Transportation Engineering	Professor	T	Fall 2020	9	0.75	0.10	0.08	9	0.75	0.15	0.11
A	Daniel Meeroff, Ph.D. Environmental Engineering	Professor	T	Fall 2020	9	0.75	0.10	0.08	9	0.75	0.15	0.11
A	Sudhagar Nagarajan, Ph.D. Geomatics Engineering	Assistant Prof.	TE	Fall 2020	9	0.75	0.05	0.04	9	0.75	0.10	0.08
A	Barry Rosson, Ph.D. Structural Engineering	Professor	T	Fall 2020	9	0.75	0.02	0.02	9	0.75	0.05	0.04
A	Panagiotis Scarlatos, Ph.D. Environmental & Water Resources	Professor	T	Fall 2020	9	0.75	0.02	0.02	9	0.75	0.05	0.04
A	Khaled Sobhan, Ph.D. Geotechnical Engineering	Professor	T	Fall 2020	12	1.00	0.02	0.05	9	0.75	0.05	0.04
A	Aleksandar Stevanovic, Ph.D. Transportation Engineering	Assoc. Prof.	T	Fall 2020	9	0.75	0.10	0.08	9	0.75	0.15	0.11
A	Hongbo Su, Ph.D. Geomatics Engineering	Assistant Prof.	TE	Fall 2020	9	0.75	0.05	0.04	9	0.75	0.10	0.08
A	Ramesh Teegavarapu, Ph.D. Water Resources	Professor	T	Fall 2020	9	0.75	0.10	0.08	9	0.75	0.15	0.11
A	James VanZwiten, Ph.D. Energy Sustainability	Res. Assi. Prof.	MYA	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.05	0.04
A	Peng Yi, Ph.D. Environmental Engineering	Assistant Prof.	TE	Fall 2020	9	0.75	0.10	0.08	9	0.75	0.15	0.11
A	Yan Yong, Ph.D. Structural Engineering	Professor	T	Fall 2020	12	1.00	0.02	0.02	12	1.00	0.05	0.05
B	New Hire, Ph.D. Environmental Engineering	Assistant Prof.	TE	Fall 2020	9	0.75	0.05	0.04	9	0.75	0.10	0.08
B	New Hire, Ph.D. Transportation Engineering	Assistant Prof.	TE	Fall 2020	9	0.75	0.05	0.04	9	0.75	0.10	0.08
C	New Hire, Ph.D. Structural/Geotechnical Eng	Assistant Prof.	TE	Fall 2021	0	0.00	0.00	0.00	9	0.75	0.15	0.11
C	New Hire, Ph.D. Transportation/Environmental	Assistant Prof.	TE	Fall 2023	0	0.00	0.00	0.00	9	0.75	0.10	0.08
A	Eric Dumbaugh, Ph.D. Urban Planning	Assoc. Prof.	T	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	Dale Gawlik, Ph.D Biological Sciences	Professor	T	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	Louis Merlin, Ph.D. Urban planning	Assistant Prof.	TE	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	Diana Mitsova, Ph.D. Urban Planning	Assoc. Prof.	T	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	Colin Polsky, Ph.D. Environmental Science	Professor	T	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	John Renne, Ph.D. Urban Planning	Assoc. Prof.	T	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	Tera Root, Ph.D. Geosciences	Assoc. Prof.	T	Fall 2020	9	0.75	0.00	0.00	9	0.75	0.00	0.00
A	Zhixiao Xie, Ph.D. Geosciences	Professor	T	Fall 2020	12	1.00	0.00	0.00	12	1.00	0.00	0.00
	Total Person-Years (PY)							**0.69**				**1.44**

Faculty Code		Source of Funding	PY Workload by Budget Classsification Year 1	Year 5
A	Existing faculty on a regular line	Current Education & General Revenue	0.53	0.88
B	New faculty to be hired on a vacant line	Current Education & General Revenue	0.16	0.30
C	New faculty to be hired on a new line	New Education & General Revenue	0.00	0.26
D	Existing faculty hired on contracts/grants	Contracts/Grants	0.00	0.00
E	New faculty to be hired on contracts/grants	Contracts/Grants	0.00	0.00
		Overall Totals for **Year 1**	**0.69**	**Year 5** **1.44**

APPENDIX C

SOUTH FLORIDA REGIONAL TRANSPORTATION AUTHORITY
801 NW 33rd Street | Pompano Beach, Florida 33064 | P 954-942-7245 | F 954-788-7961 | www.sfrta.fl.gov

March 6, 2019

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dear Dr. Yong:

The South Florida Regional Transportation Authority is pleased to support the Florida Atlantic University Department of Civil, Environmental and Geomatics Engineering's plan for a **Ph.D. program in Transportation and Environmental Engineering**. These engineering disciplines serve the technological needs of society, particularly with regard to the constructed environment, and are skills that our agency relies to accomplish our mission to enhance mobility for the residents and visitors in our region.

Our country is suffering from a shortage of engineers with rigorous technical foundation and a top level education. Southeast Florida, with its rapid population growth and unique infrastructure and environmental challenges, has a strong need for highly trained, multi-disciplined, engineers. The knowledge and skills obtained with a Ph.D. in Transportation and Environmental Engineering will help ensure the safety, security and future of our community. A much needed infusion of engineering talent will allow our region to be better prepared to adjust to rapid advances in technology as it pertains to civil engineering infrastructure and the needs of society. Programs at other Florida universities are simply too far away to effectively serve the needs of our communities.

The FAU PhD. in Transportation and Environmental Engineering will bring educational and research opportunities to assist the needs of students, engineering professionals, and employers in Florida. I strongly support this graduate program, and I am willing to collaborate with you and the faculty to make this program a success. Furthermore, offering the PhD. in Transportation and Environmental Engineering at FAU will enhance the opportunities to engage in collaborative activities.

We are confident that a new PhD. program in Transportation and Environmental Engineering at Florida Atlantic University will make a valuable contribution to the economic development of Florida and provide an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community.

Very truly yours,

Steven L. Abrams
Executive Director

The City of West Palm Beach

"The Capital City of the Palm Beaches"

Jeri Muoio, Ph.D.
Mayor
P.O. Box 3366
West Palm Beach, FL 33402
Phone: 561-822-1400
Fax: 561/822-1424
e-mail: jmuoio@wpb.org

June 30, 2014

Yan Yong
Interim Chair and Professor
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road, 36/231
Boca Raton, FL 33431

Dear Dr. Yong,

This letter is to document our support for the Department of Civil Engineering at Florida Atlantic University and its plans for a Ph.D. program in Civil Engineering. Civil Engineering serves the technological needs of society, particularly with regard to the constructed environment. Nationwide, we are suffering from a shortage of engineers that possess a rigorous technical foundation and a top level liberal education. It is especially important that future civil engineers be thoroughly prepared not only in mathematics and physics common to other engineering disciplines, but also in the important aspects of chemistry, microbiology, modeling, statistical analysis, simulation, planning, management, and climate change, which are highly desired by our industry. Without this preparation, our future engineers will find it difficult to adjust to the rapid advances in engineering as it pertains to sustainable infrastructure and the society needs.

The City of West Palm Beach is currently experiencing an upswing in development. We are seeing new buildings going up all around our City. We have also experienced difficulty hiring public sector engineers and I suspect the private sector has had the same challenges. In addition, we know how important it is to economic development to have an educated workforce. A new Ph.D. program in Civil Engineering would certainly be beneficial to West Palm Beach

In closing, we are confident that a new Ph.D. program in Civil Engineering at Florida Atlantic University will make a valuable contribution by providing a sustainable workforce of highly trained civil engineers for our industry, and we strongly support the Department's efforts to making this happen as soon as possible.

Sincerely,

Jeri Muoio
Mayor

"An Equal Opportunity Employer"

PALM BEACH
Transportation
Planning Agency

March 4, 2019

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dear Dr. Yong:

The Palm Beach Transportation Planning Agency (TPA) is pleased to support the Florida Atlantic University Department of Civil, Environmental and Geomatics Engineering's plan for a Ph.D. program in Transportation and Environmental Engineering. These engineering disciplines serve the technological needs of society, particularly with regard to the constructed environment, and the depth and breadth of knowledge that a Ph.D. program will seek to establish can only benefit the Southeast Florida region. Our rapid population growth, evolving travel patterns and behaviors, and unique infrastructure and environmental challenges pose a strong need for highly trained, multi-disciplined, engineers. The knowledge and skills obtained with a Ph.D. in Transportation and Environmental Engineering will help ensure the safety, security and future of our community.

I strongly support this graduate program and am willing to collaborate with you and the faculty to make this program a success. Furthermore, offering the Ph.D. in Transportation and Environmental Engineering at Florida Atlantic University will enhance opportunities to engage in collaborative research. The TPA's focus on transportation planning for all of Palm Beach County could benefit by the educational and cooperative opportunities associated with such a program.

We are confident that a new Ph.D. program in Transportation and Environmental Engineering at Florida Atlantic University will make a valuable contribution to the economic development of Florida and by providing an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community by providing qualified and competent professional civil engineers for the future.

Sincerely,

Nick Uhren, P.E.
Executive Director

2300 North Jog Road 4th Floor, West Palm Beach, FL 33411 | 561.684.4170 | PalmBeachTPA.org

TranSystems

3230 W. Commercial Blvd.
Suite 450
Fort Lauderdale, FL 33309
Tel 954 653-4700
Fax 954 567-2511

www.transystems.com

March 5, 2019

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dear Dr. Yong:

TranSystems Corporation and I are pleased to support the Florida Atlantic University Department of Civil Engineering's plans for a Ph.D. program in Transportation and Environmental Engineering. These engineering disciplines serve the technological needs of society with regard to the constructed environment. Nationwide, we are suffering from a shortage of engineers that possess a rigorous technical foundation upon graduation. It is important that future engineers be prepared not only in basic engineering disciplines, but in the important aspects of chemistry, microbiology, modeling, statistical analysis, simulation, planning, management, and climate change, which are highly desired by our industry. South Florida, with its rapid population growth and unique infrastructure and environmental challenges has a strong need for highly trained engineers. The knowledge and skills obtained from such a Ph.D. education will help ensure the safety, security, and long term viability of our community. A much needed infusion of engineering talent will allow our region to be better prepared to adjust to rapid advances in technology as it pertains to civil engineering infrastructure and the needs of society. Programs at other Florida universities are simply too far away to effectively serve the needs of our industry.

TranSystems' transportation consulting services span all modes and provide a full range of architectural, engineering and planning services: management and supply chain consulting services; transportation security consulting services; and transportation real estate consulting services.

The FAU Ph.D., in Infrastructure and Sustainable Engineering will bring educational and research opportunities to assist the needs of students, engineering professionals, and employers in our region. I strongly support this graduate program, and I am willing to collaborate with you and the faculty to make this program a success. Furthermore, altering the Ph.D. in Sustainable Infrastructure Engineering at FAU will enhance the opportunities to engage in collaborative research.

In closing, we are confident that a new Ph.D. program in Sustainable Infrastructure Engineering at Florida Atlantic University will make a valuable contribution to our industry by providing an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community by providing qualified and competent professional civil engineers for the future.

Sincerely,

Alan Klevens, P.E.
Principal, Sr. Vice President

SMARTSTRUCTURES

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dr. Yong:

Smart Structures is honored to continue its support to Florida Atlantic University, and is excited about the Department of Civil Engineering's plan for a **Ph.D. program in Transportation and Environmental Engineering**. It is important that future engineers be skilled in these vital disciplines: mathematics and physics common to other engineering disciplines; as well as in the crucial aspects of chemistry, microbiology, simulation, modeling, statistical analysis, planning, management and climate change. It is unfortunate that there is a national shortage of engineers that possess a rigorous technical foundation and a high-level liberal education. A program at Florida Atlantic University would be well suited to effectively serve the needs of our local communities.

South Florida's continuous population growth, unique infrastructure and environmental challenges increase the need for highly-trained, multi-disciplined, engineers with this discipline-focused Ph.D. This significant increase in engineering talent will allow South Florida to be best prepared to engage advancing technology in civil engineering infrastructure.

Smart Structures is the world leader in embedding intelligence into concrete structures. First of its kind and is internationally recognized for its innovative strategies that provide sustainable solutions to projects locally and globally. In addition to our strong local presence and expanding client base, we have several projects that employ cutting-edge technologies and processes developed and led by employees. As Smart Structures continues to expand, and the complex nature of the multi-disciplinary projects increases, the demand for highly-trained key individuals is crucial.

Smart Structures along with sister companies has offices located throughout Florida including the southeast Florida area that could directly benefit by the educational and cooperative opportunities associated with such a program. We have worked with the FAU Department of Civil Engineering in several advisory roles and have also successfully employed several students.

The FAU Ph.D. in Transportation and Environmental Engineering will provide educational and research opportunities to assist the needs of students, engineering professionals, and employers in South Florida. Additionally, this new program will further propel Florida Atlantic University toward becoming a nationally recognized research university.

I am a strong supporter of this graduate program and would be happy to collaborate with you and the faculty to help ensure this program's success. Further, we plan to employ some of the local Ph.D. graduates in the future.

Sincerely,
Smart Structures

Aneesh Goly, PhD, PE

President
Smart Structures

Hazen and Sawyer
2101 NW Corporate Boulevard, Suite 301
Boca Raton, FL, 33431 • 561.997.8070

March 4, 2019

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, Florida 33431

RE: Support for Ph.D. Program in Transportation and Environmental Engineering

Dear Dr. Yong:

Hazen and Sawyer (Hazen) is pleased to support the Florida Atlantic University Department of Civil Engineering's plan for a **Ph.D. program in Transportation and Environmental Engineering**. These engineering disciplines serve the technological needs of society, particularly with regard to the constructed environment. Nationwide, there appears to be a shortage of engineers that possess a rigorous technical foundation and a top-level liberal education. It is important that future engineers be prepared not only in mathematics and physics common to other engineering disciplines, but in the important aspects of chemistry, microbiology, modeling, statistical analysis, simulation, planning, management, and climate change, which are highly desired by our industry. Southeast Florida, with its rapid population growth and unique infrastructure and environmental challenges has a strong need for highly trained, multi-disciplined, engineers. The knowledge and skills obtained with a Ph.D. education will certainly benefit the local community. An infusion of highly educated engineering talent will allow our region to prosper and be better prepared to adjust to rapid advances in technology as it pertains to civil engineering infrastructure as well as the needs of society. While other distant institutions offer advanced degrees, this Ph.D. program will enable a local institution to effectively serve the needs of our communities.

Hazen is a global environmental engineering and management firm recognized for innovative approaches to achieving sustainable solutions to projects locally and around the world. In addition to the local presence serving a traditional client base many of our projects across the globe employ cutting edge technologies and processes developed by led employees. The continued growth of the company and increasingly complex nature of the multi-disciplinary projects demand highly trained individual key positions.

Hazen

We have worked closely with the FAU Department of Civil Engineering since its' inception in a number of advisory roles. We have watched the department grow and succeed at an unexpectedly rapid pace. We have hired student interns to assist in our various local offices with several of them continuing in a permanent role. We have also assisted in placement of students with local employers. There will continue to be a shortage of civil engineering students with advanced degrees and we believe the success of the FAU undergraduate program will translate to success at the Ph.D. level.

The FAU PhD. in Transportation and Environmental Engineering will bring educational and research opportunities to assist the needs of students, engineering professionals, and employers in our region. I strongly support this graduate program, and I am willing to collaborate with you and the faculty to make this program m a success. Furthermore, offering the PhD. in Transportation and Environmental Engineering at FAU will enhance the opportunities to engage in collaborative research. Hazen has several offices in South Florida including a local office in Boca Raton that could directly benefit by the educational and cooperative opportunities associated with such a program.

In closing, we are confident that a new PhD. program in Transportation and Environmental Engineering at Florida Atlantic University will make a valuable contribution. It will provide an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community by providing qualified and competent professional civil engineers for the future.

Sincerely,

HAZEN AND SAWYER

Albert Muniz

Albert Muniz / Vice President

CAULFIELD & WHEELER, INC.
Consulting Engineers • Surveyors & Mappers

Celebrating 35 years

Engineering EB0003591
Surveying LB0003591
Landscape Architecture LC0000318

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dear Dr. Yong,

Caulfield & Wheeler, Inc. is pleased to support the Florida Atlantic University Department of Civil Engineering's plan for a **Ph.D. program in Transportation and Environmental Engineering**. These engineering disciplines serve the technological needs of society, particularly with regard to the constructed environment. We are suffering from a shortage of engineers that possess a rigorous technical foundation and top level education. It is important that future engineers be prepared not only in mathematics and physics common to other engineering disciplines, but in the important aspects of chemistry, microbiology, modeling, statistical analysis, simulation, planning, management, and climate change, which are highly desired by our industry. Southeast Florida, with its rapid population growth and unique infrastructure and environmental challenges has a strong need for highly trained, multi-disciplined, engineers. The knowledge and skills obtained with a Ph.D. education will help ensure the safety, security and future of our community. A much needed infusion of engineering talent will allow our region to be better prepared to adjust to rapid advances in technology as it pertains to civil engineering infrastructure and the needs of society. Programs at other Florida universities are simply too far away to effectively serve the needs of our local communities.

Caulfield & Wheeler, Inc. is an engineering, surveying, construction and management firm recognized for innovative approaches to achieving sustainable solutions to significant amounts of projects. Many of our projects employ cutting edge technologies and processes developed by led employees. The continued growth of the company and increasingly complex nature of the multi-disciplinary projects demand highly trained individual key positions.

We have worked with the FAU Department of Civil Engineering since it's inception in a number of advisory roles. We have watched the department grow and succeed at an unexpectedly rapid pace. We have hired student interns to assist in our various local offices with several of them continuing in a permanent role. Every one of these students has been successful at Caulfield & Wheeler, Inc., a firm noted for its high employee standards. There will continue to be a shortage of civil engineering students with advanced degrees and we believe the success of the FAU undergraduate program will translate to success at the Ph.D. level.

The FAU PhD. in Transportation and Environmental Engineering will bring educational and research opportunities to assist the needs of students, engineering professionals, and employers in our region. I strongly support this graduate program, and I am willing to collaborate with you and the faculty to make this program m a success. Furthermore, offering the PhD. in Transportation and Environmental

Engineering at FAU will enhance the opportunities to engage in collaborative research. Caulfield & Wheeler, Inc. has two offices in the southeast Florida area that could directly benefit by the educational and cooperative opportunities associated with such a program.

In closing, we are confident that a new PhD. program in Transportation and Environmental Engineering at Florida Atlantic University will make a valuable contribution by providing an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community by providing qualified and competent professional civil engineers for the future.

Sincerely,

Ryan D. Wheeler, P.E., LEED AP, B.S.C.E. '06

GPSERV, INC.

March 3, 2019

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dear Dr. Yong:

GPServ, Inc. a division of Duncan Parnell is pleased to support the Florida Atlantic University Department of Civil, Environmental and Geomatics Engineering's plan for a **Ph.D. program in Transportation and Environmental Engineering**. These engineering disciplines serve the technological needs of society, particularly regarding the constructed environment. USA is suffering from a shortage of engineers with rigorous technical foundation and a top-level education. Southeast Florida, with its rapid population growth and unique infrastructure and environmental challenges has a strong need for highly trained, multi-disciplined, engineers. The knowledge and skills obtained with a Ph.D. in Transportation and Environmental Engineering will help ensure the safety, security and future of our community. A much-needed infusion of engineering talent will allow our region to be better prepared to adjust to rapid advances in technology as it pertains to civil engineering infrastructure and the needs of society. Programs at other Florida universities are simply too far away to effectively serve the needs of our communities.

The FAU PhD. in Transportation and Environmental Engineering will bring educational and research opportunities to assist the needs of students, engineering professionals, and employers in Florida. I strongly support this graduate program, and I am willing to collaborate with you and the faculty to make this program a success. Furthermore, offering the PhD. in Transportation and Environmental Engineering at FAU will enhance the opportunities to engage in collaborative research. We have offices located throughout Florida that could benefit by the educational and cooperative opportunities associated with such a program.
We are confident that a new PhD. program in Transportation and Environmental Engineering at Florida Atlantic University will make a valuable contribution to the economic development of Florida and by providing an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community by providing qualified and competent professional civil engineers for the future.

We greatly appreciate your consideration with this matter.

Sincerely,

Affiliate Research Faculty of Department of Geosciences at Florida Atlantic University

Earl Soeder PSM 5865

Earl Soeder
Vice President GPServ, Inc.

621 Brookhaven Drive · Orlando, FL 32803
Toll Free 888-782-1997 · Local 407-601-5816 · Fax 407-601-5826

THE VILLAGE OF WELLINGTON

A GREAT HOMETOWN

March 11, 2019

Dr. Yan Yong, Professor and Chair
Department of Civil, Environmental and Geomatics Engineering
Florida Atlantic University
777 Glades Road
Boca Raton, FL, 33431

Dear Dr. Yong:

I am pleased to support the Florida Atlantic University Department of Civil, Environmental and Geomatics Engineering's plan for a **Ph.D. program in Transportation and Environmental Engineering**. These engineering disciplines serve the technological needs of society, particularly with regard to the constructed environment. USA is suffering from a shortage of engineers with rigorous technical foundation and a top level education. Southeast Florida, with its rapid population growth and unique infrastructure and environmental challenges has a strong need for highly trained, multi-disciplined, engineers. The knowledge and skills obtained with a Ph.D. in Transportation and Environmental Engineering will help ensure the safety, security and future of our community. A much needed infusion of engineering talent will allow our region to be better prepared to adjust to rapid advances in technology as it pertains to civil engineering infrastructure and the needs of society.

The FAU PhD. in Transportation and Environmental Engineering will bring educational and research opportunities to assist the needs of students, engineering professionals, and employers in Florida. I strongly support this graduate program, and I am willing to collaborate with you and the faculty to make this program a success. Furthermore, offering the PhD. in Transportation and Environmental Engineering at FAU will enhance the opportunities to engage in collaborative research.
We are confident that a new PhD. program in Transportation and Environmental Engineering at Florida Atlantic University will make a valuable contribution to the economic development of Florida and by providing an important step forward for Florida Atlantic University in its evolution into a premier, nationally recognized research university supporting the needs of the State of Florida and the engineering community by providing qualified and competent professional civil engineers for the future.

Sincerely,

Anne Gerwig
Village of Wellington

12300 Forest Hill Boulevard • Wellington, Florida 33414 • (561) 791-4000 • Fax (561) 791-4045
www.wellingtonfl.gov

APPENDIX D

MARKET ANALYSIS – PHD IN CIVIL AND ENVIRONMENTAL ENGINEERING

Prepared for Florida Atlantic University

March 2019

In the following report, Hanover Research examines student and labor market demand for a PhD degree with a Major in Civil and Environmental Engineering. Hanover also analyzes the market saturation for graduates and provides an overview of competitor programs.

HANOVER RESEARCH

www.hanoverresearch.com

TABLE OF CONTENTS

Executive Summary

Introduction

Florida Atlantic University (FAU) proposes to create a PhD program with a Major in Civil and Environmental Engineering. In the following report, Hanover Research (Hanover) provides an overview of the market for civil and environmental engineering doctorate programs in Florida and Southeast Florida to inform program viability and design. This report consists of three sections:

- **Section I: Student Demand** examines student demand for a doctoral degree that combines civil and environmental engineering, considering current enrollment and degree completion trends in the Florida University System.
- **Section II: Labor Market Demand** examines employment projections for civil and environmental engineering related occupations at the state and local levels, and identifies top employers in Southeast Florida.
- **Section III: Competitor Scan** assesses the competitive landscape for the proposed program in Florida and common curriculum requirements.

Recommendations

- FAU should move forward with marketing its program as a combined PhD degree in civil and environmental engineering, as this would be unique in Florida.
- FAU should position its degree as one that will prepare graduate for careers as both academic researchers *and* practitioners to best meet the region's workforce needs.
- Given that existing online/hybrid programs are very limited at the doctoral level, FAU should explore why this may be the case through in-depth interviews with other institutions that offer PhD degrees in Civil and/or Environmental Engineering.
  - Hanover recommends targeting institutions that offer some coursework online for interviews (e.g., institutions that offer a master's degree in civil and environmental engineering online, but not their PhD; institutions that offer a PhD in civil engineering in a hybrid format).
  - Interviews can be used to uncover information on student enrollment and demand for online and hybrid programming, logistical considerations, potential challenges, and recommended structure for FAU's proposed program.
- FAU might also consider conducting a prospective student survey or interviews to gain further insight into student interest at the PhD level, particularly in terms of delivery format.

Key Findings

- **Job opportunities related to civil and environmental engineering in Southeast Florida are plentiful and expected to grow by 2025**. Above average job growth is projected for Postsecondary Engineering Teachers, Environmental Engineers, and Civil Engineers in Workforce Regions 20 through 22. Across these three occupations, total annual job openings are expected to average 378, with the largest number of

openings for civil engineers. However, vacancies for engineering professors will be limited.

- **Combined civil and environmental engineering programs have expanded rapidly, with more than five times as many students enrolled in 2015 as in 2006**. However, this is still a relatively small field, with approximately 1,200 PhD enrollments nationwide in 2015. Enrollment trends for civil and environmental engineering PhD programs in Florida suggest that student demand has been steady over the past five years, with most programs enrolling between 30 and 60 students in 2017. In sum, these trends suggest that FAU's goals of enrolling 7 to 10 students in the first year and five students per year thereafter would be feasible. However, a prospective student survey is recommended to ensure sufficient student interest.
- **FAU's proposed program would be the first of its kind in Florida and among the first nationwide.** In Florida, students must choose between a PhD in Civil Engineering (offered by six universities) or a PhD in Environmental Engineering (offered by three universities). Likewise, no Florida competitors offer online or hybrid options for coursework, like FAU has proposed. FAU's closest competitors would likely be Florida International University, University of Miami, and Florida State University-FAMU, which all offer PhD programs in Civil Engineering with concentrations in Environmental Engineering. A review of combined Civil and Environmental Engineering programs nationally only identified one institution that formally offers a hybrid PhD program.
- **FAU's proposed credit requirements are slightly lower than those of competitor programs, but its curriculum requirements are similar**. FAU's proposed total credits beyond the bachelor's degree (72 credits) is slightly lower than the competitor average (76.5 credits). Like FAU's proposal, nearly all competitor programs require a qualifying exam, dissertation proposal defense, and dissertation defense. However, unlike FAU, most competitor programs do *not* include a publication requirement.

Section I: Student Demand

To assess potential student demand for a doctorate degree in civil and environmental engineering, Hanover examines enrollment and degree completion trends at the national and state levels.

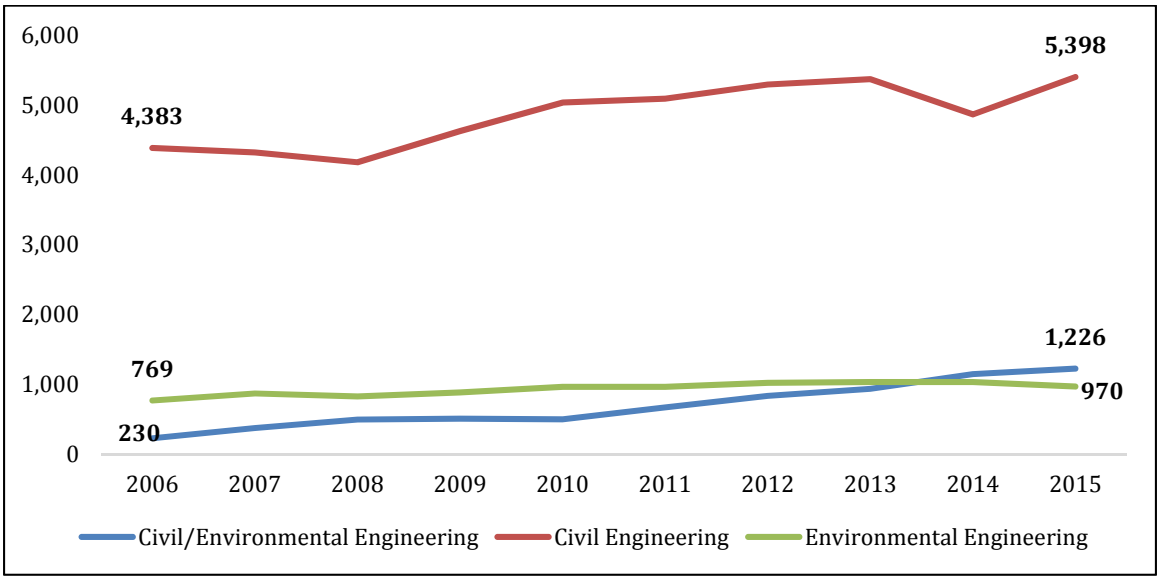
Enrollment Trends

The American Society for Engineering Education (ASEE) tracks annual enrollments in engineering disciplines for 358-member institutions.[1] The ASEE recognizes three relevant engineering disciplines related to the fields of civil and environmental engineering: combined civil and environmental engineering, civil engineering, and

[1] "Online Profiles." American Society for Engineering Education (ASEE). http://profiles.asee.org/

environmental engineering. Enrollment in civil engineering doctorate programs has historically been much higher than enrollment in civil and environmental engineering or environmental engineering programs. However, **combined civil and environmental engineering PhD programs have expanded rapidly, with more than five times as many students enrolled in 2015 as in 2006**.[2] In fact, in 2014, Civil/Environmental Engineering enrollments surpassed Environmental Engineering enrollments. These trends suggest that students are increasingly interested in enrolling in combined civil and environmental engineering doctoral programs.

Figure 1.1: National Doctorate Enrollment in Civil and Environmental Engineering Programs, 2006-2015



Source: ASEE[3]

Note: Enrollment reflects both full-time and part-time students.

Degree Completions

In the following section, Hanover analyzes degree completions trends as reported by the National Center for Education Statistics (NCES) Integrated Postsecondary Education Data System (IPEDS). Hanover analyzes degree completions trends in terms of three metrics: compound annual growth rate (CAGR), average annual change (AAC), and the standard deviation of the year-to-year change (STDEV).

- **CAGR** reflects the percentage growth that would occur each year if one assumed the same change occurred yearly between the first year and the final year. It gives an impression of a theoretical, steady growth rate by ignoring data presented during middle years.

[2] Yoder, B. "Engineering by the Numbers." American Society for Engineering Education (ASEE). pp. 43-44. https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf

[3] Ibid.

- **AAC** shows average year-to-year differences. It allows for a more comprehensive view of the yearly average change in completions, with each year playing a role in determining the figure.
- **STDEV** indicates how significantly each year's change varies from the AAC. The larger the STDEV, the greater amount of variance present over a five-year period. Inconsistency in STDEV does not necessarily mean a negative outcome—growth patterns that rapidly accelerate over time will have a higher STDEV than generally consistent ones.

A full description of the methodologies used in this section and definitions of individual fields can be found in the Appendix at the end of this report.

National Trends

Nationally, student demand for doctoral programs in civil and environmental engineering and related fields increased between 2012 and 2016, with an annualized growth of 6.1 percent. This compares favorably to the annualized growth rate seen across all PhD programs in the United State during this same period (2.8 percent).

Civil Engineering, General awarded over 950 doctorate degrees in 2016, accounting for the majority of completions, and reported above average annual growth of 6.1 percent. *Environmental/ Environmental Health Engineering* awarded far fewer degrees by comparison and reported 2.6 percent annualized growth, in line with the national average. Across the other fields examined, *Biological/ Biosystems Engineering*, *Geological/ Geophysical Engineering*, and *Surveying Engineering* recorded the highest growth in conferrals overall. However, each of these fields is very small, graduating fewer than 30 PhD students in a single year.

Figure 1.2: National Doctor's Degree Completions in Civil and Environmental Engineering Related Fields, 2012-2016*

CIP Category	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
Civil Engineering, General	756	840	939	990	959	6.1%	51	50
Structural Engineering	12	11	9	25	20	13.6%	2	8
Transportation and Highway Engineering	10	7	9	9	15	10.7%	1	3
Water Resources Engineering	13	11	12	14	12	-2.0%	0	2
Civil Engineering, Other	1	0	6	2	4	41.4%	1	4
Environmental/Environmental Health Engineering	127	158	166	171	141	2.6%	4	22
Materials Engineering	549	600	589	637	670	5.1%	30	25
Construction Engineering	-	1	0	1	1	-	-	-
Surveying Engineering	2	0	0	1	9	45.6%	2	4

CIP Category	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
Geological/Geophysical Engineering	4	16	18	15	21	51.4%	4	5
Biological/Biosystems Engineering	2	9	15	26	21	80.0%	5	6
Total	**1,476**	**1,653**	**1,763**	**1,891**	**1,873**	**6.1%**	**99**	**72**

Source: IPEDS
*Includes degree completions reported under the award level "Doctor's degree – research/scholarship." Note that the following CIP fields reported zero completions at the doctorate level: 14.0802 Geotechnical and Geoenvironmental Engineering and 14.4401 Engineering Chemistry.

Distance Education Programs

IPEDS reports the past five years of "distance" program completions, which rely on "one or more technologies to deliver instruction to students who are separated from the instructor." However, programs classified as distance education are not necessarily fully online and may involve residential requirements. Additionally, because IPEDS does not disaggregate distance and onsite completions by institution, there is no way to determine the number of distance completions within a given academic field, only the number of institutions that report offering a distance program.

As shown in Figure 1.3, **there are very few universities in the United States that offer distance learning options for doctorate degrees in civil and environmental engineering**. One such institution is the University of South Carolina – Columbia. The College of Engineering and Computing "offers certain online courses for busy professionals seeking advanced degrees...Students in the program view their classes via streaming video" with "various courses offered three times a year following a tri-semester plan."[4] While their PhD in Civil Engineering is not specifically marketed as a hybrid program, students may take advantage of the online coursework.[5] However, all doctoral-level programs "require a research component that must be done in residence."[6]

Overall, these trends suggest that FAU would be creating a unique PhD program by offering the proposed degree fully or partially online. However, given that distance completions are so limited at the doctoral level, Hanover recommends speaking with the programs that do offer online or hybrid options directly to understand if there are any other impediments to offering core coursework fully online. Likewise, FAU could also speak with combined PhD programs that offer onsite options only to understand if they have considered offering their degrees online and what their opinion of alternative delivery methods would be.

[4] "Distance Education." University of South Carolina. https://sc.edu/study/colleges_schools/engineering_and_computing/study/programs_degrees/distance/index.php

[5] "Doctoral (Ph.D.) Degree." College of Engineering and Computing University of South Carolina. https://sc.edu/study/colleges_schools/engineering_and_computing/study/civil_and_environmental_engineering/degree_programs/phd-degree.php

[6] "Distance Education," Op. cit.

Figure 1.3: Degree Conferrals at Institutions offering Distance Learning Options in Civil and Environmental Engineering, 2012-2016

Institution	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
Civil Engineering, General								
Columbia University in the City of New York	7	13	7	9	10	9.3%	1	4
University of Alabama Huntsville	-	-	-	2	2	-	-	-
University of South Carolina - Columbia	6	6	11	9	4	-9.6%	-1	4
Total	**13**	**19**	**18**	**20**	**16**	**5.3%**	**1**	**6**
Environmental/Environmental Health Engineering								
Columbia University in the City of New York	4	4	-	-	-	-	-	-
Total	**4**	**4**	**-**	**-**	**-**	**-**	**-**	**-**
Materials Engineering								
Texas A&M University – College Station	7	18	17	-	-	-	-	-
Total	**7**	**18**	**17**	**-**	**-**	**-**	**-**	**-**
Total, All Fields	**24**	**41**	**35**	**20**	**16**	**-9.6%**	**-2**	**12**

Source: IPEDS

State Trends

Doctorate conferral trends for civil and environmental engineering fields in Florida are less promising, with an annual decrease of 2.1 percent between 2012 and 2016. **Except for the University of Florida, most competitor programs are small – graduating between 2 and 13 students in 2016**. However, based on these trends, FAU's goal to graduate five students per year seems tenable with the proper recruitment strategy.

In Southeast Florida specifically, the only two universities producing PhD graduates in civil and environmental engineering fields are Florida International University (FIU) and the University of Miami (UMiami). The competitive landscape in Florida is discussed further in Section III.

Figure 1.4: Florida Doctor's Degree Completions in Civil and Environmental Engineering Related Fields, 2012-2016

Institution	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
Civil Engineering, General								
Florida Agricultural and Mechanical University	-	1	0	1	-	-	-	-
Florida Institute of Technology	2	1	-	2	2	-	-	-
Florida International University	7	9	8	11	11	12.0%	1	2
Florida State University	2	2	0	4	2	0.0%	0	2
University of Central Florida	9	5	8	11	13	9.6%	1	3

INSTITUTION	2012	2013	2014	2015	2016	CAGR	AAC	STDEV
University of Florida	16	13	15	11	13	-5.1%	-1	3
University of Miami	2	6	4	3	4	18.9%	1	2
University of South Florida	15	9	7	8	6	-20.5%	-2	2
Total	**53**	**46**	**42**	**51**	**51**	**-1.0%**	**-1**	**6**
Environmental/Environmental Health Engineering								
University of Central Florida	1	3	1	5	4	41.4%	1	2
University of Florida	9	10	20	7	4	-18.4%	-1	8
University of South Florida	-	1	1	3	4	-	-	-
Total	**10**	**14**	**22**	**15**	**12**	**4.7%**	**1**	**6**
Materials Engineering								
Florida International University	4	7	4	3	3	-6.9%	0	2
University of Central Florida	4	10	4	3	3	-6.9%	0	4
University of Florida	28	23	24	20	22	-5.9%	-2	3
Total	**36**	**40**	**32**	**26**	**28**	**-6.1%**	**-2**	**5**
Total, All Fields	**99**	**100**	**96**	**92**	**91**	**-2.1%**	**-2**	**2**

Source: IPEDS

Section II: Labor Market Demand

In the following section, Hanover examines employment projections and job posting trends associated with the proposed PhD with a Major in Civil and Environmental Engineering.

Employment Projections

State labor market projections align with occupations as defined by the Bureau of Labor Statistics' (BLS) Standard Occupational Code (SOC) system. The SOC system is analogous to the CIP system, and the two are connected by the CIP-SOC crosswalk, which maps individual (six-digit) degree programs to (six-digit) occupations. [7] Hanover uses this crosswalk to develop a list of SOC-defined occupations to assess labor market demand for individuals with training in civil and environmental engineering. Table 2.1 presents the BLS crosswalk-identified occupations related to a degree in civil and environment engineering that typically require at least a bachelor's degree for entry into the field. Of note, the only occupations in this crosswalk that *require* a doctorate degree are *Engineering Teachers, Postsecondary* and *Environmental Science Teachers, Postsecondary*. However, graduate level education is still common across many of the professions listed below. For example, 26.1 percent of Civil Engineers hold master's degrees, and 4.0 percent hold doctorate or professional degrees.[8]

[7] "CIP 2010 to SOC 2010 Crosswalk." National Center for Education Statistics (NCES). http://nces.ed.gov/ipeds/cipcode/resources.aspx?y=55

[8] "Educational Attainment for Workers 25 Years and Older by Detailed Occupation." Bureau of Labor Statistics. https://www.bls.gov/emp/ep_table_111.htm

Table 2.1: SOC Codes and Titles

SOC Code	Employment Description Title
11-1011	Chief Executives
11-1021	General and Operations Managers
11-3071	Transportation, storage, and distribution managers
11-9021	Construction Managers
11-9041	Architectural and Engineering Managers
11-9161	Emergency Management Directors
17-1011	Architects, except landscape and naval
17-1012	Landscape Architects
17-1021	Cartographers and Photogrammetrists
17-1022	Surveyors
17-2051	Civil Engineers
17-2081	Environmental Engineers
17-2111	Health and Safety Engineers
17-2112	Industrial Engineers
17-2121	Marine Engineers and Naval Architects
17-2131	Materials Engineers
17-2151	Mining and Geological Engineers
19-1031	Conservation Scientists
19-2041	Environmental Scientists and Specialists
19-2042	Geoscientists, Except Hydrologists and Geographers
19-2043	Hydrologists
19-3051	Urban and Regional Planners
25-1032	Engineering Teachers Postsecondary
25-1053	Environmental Science Teachers Postsecondary
41-9031	Sales Engineers
47-2073	Operating Engineers and other construction
47-4011	Construction and building inspectors

Source: BLS

State Trends

Overall, openings for civil and environmental engineering related occupations in Florida are projected to increase by 12.5 percent from 2017 to 2025. This is slightly above the average growth rate projected for all occupations in the state during this period (11.3 percent). The occupations projected to see the highest growth include: *Cartographers and Photogrammetrists* (33.9 percent), *Biomedical Engineers* (23.7 percent), and *Engineering Teachers, Postsecondary* (16.7 percent). However, *Civil Engineers* and *Environmental Engineers* are also projected to grow at above average rates of 15.2 percent and 14.6 percent, respectively. Across all occupations considered, *Civil Engineers* are expected to have the highest total volume of job openings by far.

Figure 2.2: Florida Projections for Occupations Related to Civil and Environmental Engineering, 2017-2025

SOC Code	Title	Employment		Projected Change		Total Job Openings
		2017	2025	Number	Percent	
11-9041	Architectural and Engineering Managers	6,830	7,665	835	12.2%	4,609
17-1021	Cartographers and Photogrammetrists	579	775	196	33.9%	599
17-1022	Surveyors	3,718	3,946	228	6.1%	2,511
17-2031	Biomedical Engineers	725	897	172	23.7%	571
17-2041	Chemical Engineers	451	496	45	10.0%	290
17-2051	Civil Engineers	18,882	21,759	2,877	15.2%	14,822
17-2081	Environmental Engineers	2,704	3,098	394	14.6%	2,089
17-2111	Health and Safety Engineers	962	1,083	121	12.6%	641
17-2112	Industrial Engineers	10,221	11,024	803	7.9%	6,204
17-2121	Marine Engineers and Naval Architects	299	334	35	11.7%	154
17-2131	Materials Engineers	588	645	57	9.7%	340
19-1031	Conservation Scientists	287	322	35	12.2%	272
19-2041	Environmental Scientists and Specialists, Including Health	5,721	6,352	631	11.0%	5,153
19-2042	Geoscientists	626	719	93	14.9%	597
19-2043	Hydrologists	253	292	39	15.4%	243
25-1032	Engineering Teachers, Postsecondary	1,727	2,015	288	16.7%	1,460
25-1053	Environmental Science Teachers, Postsecondary	112	125	13	11.6%	87
41-9031	Sales Engineers	2,037	2,261	224	11.0%	1,829
Total		**56,722**	**63,808**	**7,086**	**12.5%**	**42,471**

Source: FDEO[9]

Note: Occupational projections for SOC code 17-2151 Mining and Geological Engineers are not reported for Florida.

Local Trends

The Florida Department of Economic Opportunity (FDEO) provides local labor projections for the largest counties and single county workforce regions in the state. To approximate labor market demand in FAU's region, Hanover examines occupational projections for Workforce Regions 20 through 22, which encompass Palm Beach, Broward, Indian River, Martin, and Saint Lucie Counties.

In Southeast Florida, civil and environmental engineering related occupations are projected to grow at a rate of 13.9 percent through 2025 – slightly faster than the state growth rate. The FDEO projects the highest growth for *Biomedical Engineers*, with are expected to increase by 32.1 percent. Strong growth is also projected for *Engineering Teachers, Postsecondary* (19.0 percent), *Environmental Engineers* (16.3

[9] "Employment Projections." Florida Department of Economic Opportunity (FDEO). http://www.floridajobs.org/labor-market-information/data-center/statistical-programs/employment-projections

percent), and *Civil Engineers* (15.3 percent). Across these three occupations, total *annual* job openings are expected to average 378, which would suggest a sizeable job market for graduates of FAU's proposed program.

However, it is worth noting that job openings for engineering professors will be limited to only about 20 per year across all engineering disciplines. For this reason, FAU should position its degree as one that will prepare graduate for careers as both academic researchers *and* practitioners to best meet the region's workforce needs.

Figure 2.3: Southeast Florida Projections for Occupations Related to Civil and Environmental Engineering, 2017-2025

SOC Code	Title	Employment		Projected Change		Total Job Openings Due to Growth
		2017	2025	Number	Percent	
11-9041	Architectural and Engineering Managers	934	1,058	124	13.3%	643
17-1022	Surveyors	771	843	72	9.3%	551
17-2031	Biomedical Engineers	81	107	26	32.1%	73
17-2051	Civil Engineers	3,050	3,517	467	15.3%	2,398
17-2081	Environmental Engineers	584	679	95	16.3%	464
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	148	164	16	10.8%	95
17-2112	Industrial Engineers	1610	1802	192	11.9%	1,124
17-2121	Marine Engineers and Naval Architects	15	19	4	26.7%	10
17-2131	Materials Engineers	73	83	10	13.7%	45
19-1031	Conservation Scientists	44	49	5	11.4%	41
19-2041	Environmental Scientists and Specialists, Including Health	1,005	1,120	115	11.4%	912
19-2042	Geoscientists, Except Hydrologists and Geographers	76	92	16	21.1%	78
19-2043	Hydrologists	30	37	7	23.3%	32
25-1032	Engineering Teachers, Postsecondary	184	219	35	19.0%	162
41-9031	Sales Engineers	385	448	63	16.4%	373
Total, Workforce Regions 20-22		**8,990**	**10,237**	**1,247**	**13.9%**	**7,001**

Source: FDEO[10]

Note: Occupational projections for SOC code 17-1021 Cartographers and Photogrammetrists, 17-2041 Chemical Engineers, 17-2151 Mining and Geological Engineers, and 25-1053 Environmental Science Teachers, Postsecondary are not reported for Southeast Florida.

Salary Data

[10] Ibid.

Salary data from the BLS indicates professionals who work in fields related to civil and environmental engineering can expect salaries between $63,520 and $132,130. As shown in Figure 2.4, the highest salary is for *Architecture and Engineering Managers.* However, since all occupations besides *Postsecondary Engineering Teachers* require at least a bachelor's degree, a doctorate degree would likely increase a candidate's earning potential.

Figure 2.4: Annual Salaries for Civil and Environmental Engineering Related Occupations in Southeast Florida, May 2016*

Occupation	Annual Mean Wage
Architecture and Engineering Managers	$148,950
Surveyors	$55,890
Civil Engineers	$94,190
Environmental Engineers	$72,040
Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	$64,740
Industrial Engineers	$81,730
Materials Engineers	$84,870
Environmental Scientists and Specialists, Including Health	$68,500
Geoscientists, Except Hydrologists and Geographers	$85,070
Engineering Teachers, Postsecondary	$117,110
Sales Engineers	$110,920

Source: BLS[11]

*Salary data not available for Biomedical Engineers, Chemical Engineers, Cartographers, Marine Engineers, Mining and Geological Engineers, Conservation Specialists, Hydrologists, or Environmental Science Teachers Postsecondary. Note: Salaries for Southeast Florida are estimated using BLS data for the West Palm Beach-Boca Raton-Delray Beach, FL metropolitan division, which includes Palm Beach County. Note that the BLS does not report average salaries by workforce region.

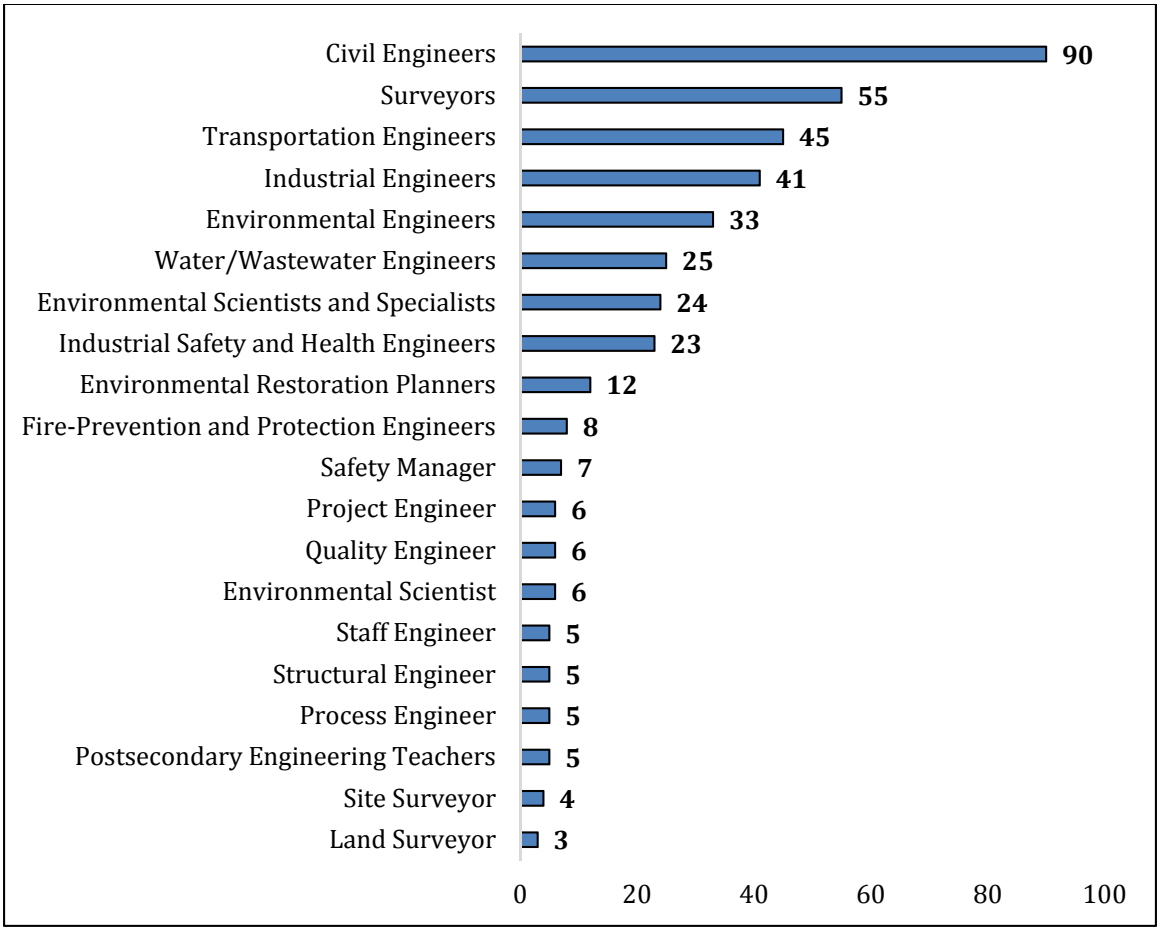
Job Posting Trends

Using job posting data from JobsEQ, a proprietary database providing real-time job postings aggregated from thousands of websites, Hanover analyzed job postings data for the Miami-Fort Lauderdale-Palm Beach MSA, which includes Miami-Dade, Broward, and Palm Beach counties. Figure 2.5 shows the job titles appearing in this area over a 30-day period. Consistent with occupational projections data, **the highest volume of job postings (90) are for Civil Engineers.** By comparison, there are currently 33 job postings for Environmental Engineers and 24 job postings for Environmental Scientists and Specialists. Surveyors can also expect ample employment opportunities in the Southeast Florida Region with 55 job openings in the past month.

Among these jobs postings, the top "soft skills" requested include: communication, cooperative/team player, self-motivated, supervision/management, project management, analytical thinking, problem solving, detail-oriented, initiative, and organization.

[11] "May 2016 OES Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates." Bureau of Labor Statistics. https://www.bls.gov/oes/current/oes_48424.htm

Figure 2.5: Top Civil and Environmental Engineering Occupations in Southeast Florida, by Number of Job Postings

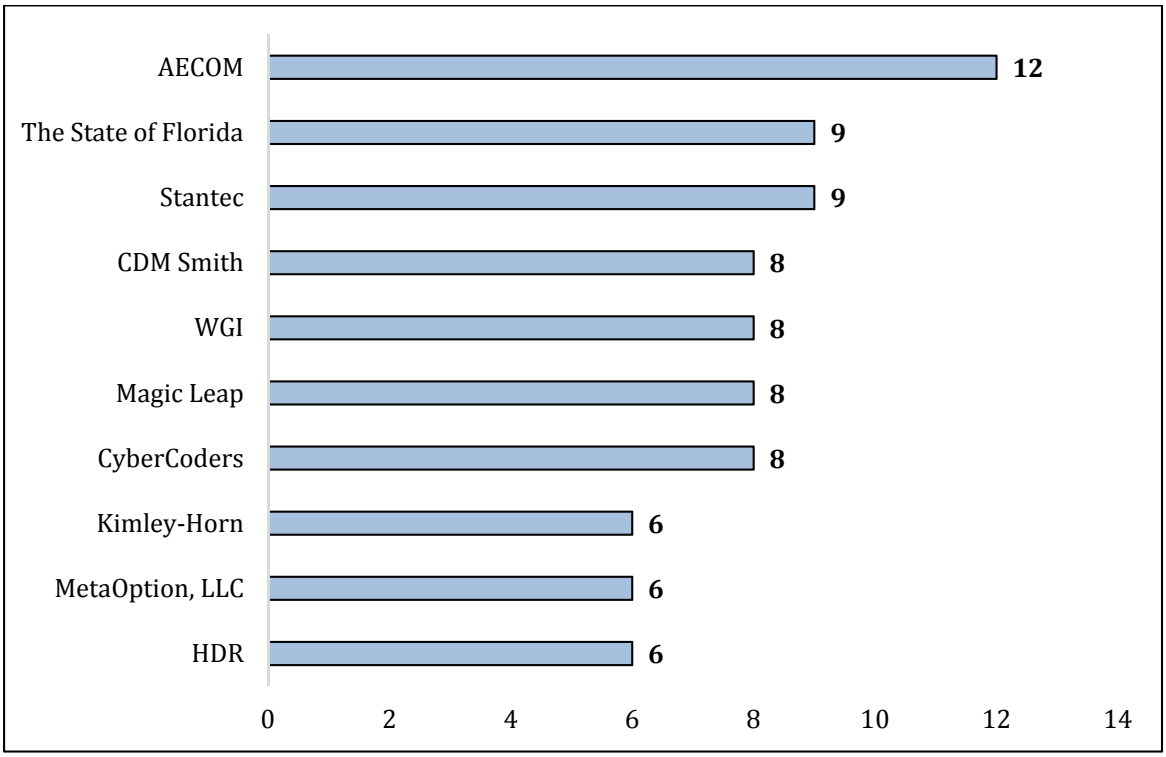


Source: JobsEQ
Note: JobsEQ South Florida data represents the Miami-Fort Lauderdale-Palm Beach MSA, including Miami-Dade, Broward, and Palm Beach counties. Data reflect job postings for the 30-day period ending 3/15/2018

Figure 2.6 shows the top employers advertising civil and environmental engineering related positions in the Miami-Fort Lauderdale-Palm Beach MSA. Top employers by total number of job postings include: AECOM, The State of Florida, and Stantec. AECOM describes itself as a "multinational engineering firm,"[12] while Stantec is "an international professional services company in the design and consulting industry."[13]

[12] "About." AECOM. https://www.aecom.com/about-aecom/
[13] "About." Stantec. https://www.stantec.com/en/about

Figure 2.6: Top Employers for Civil and Environmental Engineering Related Occupations in Southeast Florida, By Total Ads



Source: JobsEQ
Note: JobsEQ South Florida data represents the Miami-Fort Lauderdale-Palm Beach MSA. Data are for employers seeking job titles referenced in figure 2.4. Data reflect job postings for the 30-day period ending 3/15/2018.

Again, most civil and environmental engineering occupations require at least a bachelor's degree. However, some top employers within a 100-mile radius of FAU do require a MS or PhD. For instance, a search on Indeed.com identified employers such as Kimley-Horn and Associates, Inc requiring either an MS or PhD degree for an entry-level engineering position within their Water/Wastewater and Advanced Treatment team.[14]

Section III: Competitor Scan

In this section, Hanover assesses the competitive landscape for FAU's proposed program though surveying PhD programs in civil and environmental engineering within the University System of Florida as well as private institutions in the state. This section begins with a discussion of competitive saturation across both onsite and online/hybrid programs and concludes with an analysis of curricular requirements across competitors.

Competitive Saturation

Florida Competitors

[14] "PhD Civil Engineering Jobs, Employment in Boca Raton, FL | Indeed.Com." https://www.indeed.com/jobs?q=PhD%20civil%20Engineering&l=Boca%20Raton%2C%20FL&radius=100&vjk=2acad323a7c47c3e

The NCES reports no doctorate degree completions in civil or environmental engineering fields within Workforce regions 20, 21, and 22 between 2012 and 2016. Florida International University and the University of Miami are therefore FAU's closest competitors geographically. Figure 3.1 provides an overview of all doctorate programs related to civil and environmental engineering identified in the University System of Florida. In addition, FAU will likely compete with the University of Miami's PhD in Civil Engineering.

Notably, FAU'S proposed PhD in Civil and Environmental Engineering differs from competitors in that **no other Florida university offers a combined PhD in civil and environmental engineering**. Likewise, no Florida competitors offer online or hybrid options for coursework, like FAU has proposed. However, three competitors in the state (Florida International University, University of Miami, and Florida State University-FAMU) do offer PhD programs in Civil Engineering with concentrations in Environmental Engineering. These concentration areas are described as "research specialties," though they are typically not associated with required core coursework. Offering a combined degree program would therefore distinguish FAU from the rest of the current programs in the State University System of Florida.

Figure 3.1: Overview of Doctorate Programs Related to Civil and Environmental Engineering in the University System of Florida*

Institution	Program	Concentrations	Total Credits	Dissertation Hours	Delivery Format
Florida International University	PhD in Civil Engineering	Structural Construction and Geotechnical, Environmental and Water Resources, Transportation	90	24	On-Campus
University of Florida	PhD in Civil Engineering	Coastal & Oceanographic, Coastal Ecosystem Dynamics, Geosystems, Materials & Pavements, Public Works, Structural, Sustainable Construction, Transportation, Water Systems	90	12	On-Campus
	PhD in Environmental Engineering	Air Resources, Coastal Ecosystems, Environmental Nanotechnology, Systems Ecology	90	12	On-Campus
University of Central Florida	PhD in Civil Engineering	Geotechnical, Structural, Transportation Systems, Water Resources, Construction Management	72	18	On-Campus
	PhD in Environmental Engineering	Water Process, Waste Treatment, Air Quality	72	18	On-Campus
University of Miami	PhD in Civil Engineering	Civil, Architectural, or Environmental Engineering	60	18	On-Campus
Florida State University-FAMU**	PhD in Civil Engineering	Structures, Environmental, Transportation, Construction, Water Resources, and Geotechnical	69	24	On-Campus
University of South Florida	PhD in Civil Engineering	International Development, Geotechnical, Materials Science, Structures, Transportation, Water Resources	78	20	On-Campus
	PhD in Environmental Engineering	--	78	20	On-Campus

Source: Institutional Websites, NCES
Note: Credits required beyond baccalaureate degree. Dissertation hours included in total credits.
*University of Miami is a private institution not in the State University System of Florida.
**Joint program between Florida State University and Florida Agricultural and Mechanical University.

National Online Competitors

Nationally, the ASEE identifies 26 universities that offer combined civil and environmental engineering PhD programs, similar to what FAU has proposed.[15] These programs offer both civil engineering and environmental engineering topics as core coursework, rather than as concentrations, such as The University of South

[15] "Alphabetical Index of Participating Degree Programs." American Society for Engineering Education (ASEE). https://www.asee.org/papers-and-publications/publications/college-profiles/2015-graduate-engineering-degrees.pdf

Carolina's PhD in Civil Engineering referenced in Section I.[16] A complete listing of joint civil and environmental engineering programs can be found on the ASEE's Alphabetical List of Participating Graduate Degree Programs, which is referenced in the footnote below.

Hanover reviewed civil and environmental engineering department websites for 30 institutions, including those listed by the ASEE, in order to determine if any offer hybrid or online PhD programs not captured by IPEDS data. One such program was identified at **Clarkson University** (see profile below). Two of the institutions reviewed – Stanford University and the University of Illinois - do offer master's degrees in civil and environmental engineering online, but not doctoral degrees.[17] Given the scarcity of existing online and hybrid PhD programs in civil and environmental engineering, Hanover also searched for PhD programs within the separate fields of civil engineering or environmental engineering and identified six with hybrid options (Figure 3.2).

Even within the broader fields of civil engineering and environmental engineering, offering formal online or hybrid PhD programs appears to be rare. Some institutions may offer a master's degree and/or individual courses online, which may make it possible for students to complete some of their PhD degree coursework requirements off-campus. However, such PhD programs are rarely marketed specifically as a hybrid program. Among existing competitors, the typical target audience is full-time onsite students who are interested in conducting research.

Clarkson University (New York)

PhD in Civil & Environmental Engineering Off Campus Option

Clarkson offers an "off campus" PhD program option for students in 12 different fields of study, including Civil & Environmental Engineering. The off campus option is designed for working professionals when their "PhD research directly aligns with research needs of [their] employer." In collaboration with research advisors from Clarkson, students work with a co-advisor at their place of employment to develop a research project that meets the requirements of the PhD program. Employers must also meet Clarkson's conflict of interest policy requirements.

Students can transfer up to 30 credits towards the 90 credit coursework requirement and also complete up to 9 credits through online courses offered by Clarkson. Each individual department "specif[ies] the period of time the student spends on campus (at the department) and the number of visits (each semester)."[18] However, the Department of Civil & Environmental Engineering does not publish these requirements online.

[16] "Doctoral (Ph.D.) Degree," Op. cit.

[17] [1] "Civil and Environmental Engineering MS Degree." Stanford Online. https://online.stanford.edu/programs/civil-and-environmental-engineering-ms-degree [2] "CEE Online" University of Illinois Department of Civil and Environmental Engineering. http://cee.illinois.edu/academics/graduate-programs/cee-online

[18] [1] "Programs." Clarkson University. http://internal.clarkson.edu/offcampus/about.html

Figure 3.2: Hybrid Civil *or* Environmental Engineering PhD Programs

Institution	Program Name	Format	Program Size (includes Onsite and Hybrid)
Auburn University[19]	PhD in Civil Engineering	Hybrid *"with departmental approval"*	54 PhD students enrolled in Spring 2018[20]
Columbia University[21]	PhD in Earth and Environmental Engineering	Hybrid *"partially online"*	n/a
Illinois Institute of Technology[22]	PhD in Civil Engineering PhD in Environmental Engineering	Hybrid *"online courses available"* *"PhDs offered online on a case by case basis"*	3 Civil Engineering PhD completions in 2016[23]
Mississippi State University[24]	PhD in Civil Engineering	Hybrid	0 PhD completions in 2017[25]
University of Alabama Huntsville[26]	PhD in Civil Engineering	Hybrid *"offered primarily through an online format"*	7 PhD completions in 2017[27]
University of South Carolina, Columbia[28]	PhD in Civil Engineering	Hybrid	4 PhD completions in 2016[29]

Note: Institutions provide very limited information about the hybrid program format online. Additional primary research is recommended to uncover additional details on student demand and program structure.

Enrollments

To complement NCES completions trends discussed in Section I, the Florida State University System Board of Governors also publishes enrollment data, which provides a more up to date picture of student demand in the state.

[19] "Civil Engineering." College of Engineering Auburn University. http://eng.auburn.edu/files/online/gop-civil.pdf
[20] "Headcount Enrollment by College, Curriculum, and Level, Spring 2018." Auburn University. https://web.auburn.edu/ir/factbook/enrollment/enrtrends/enrbycurr/Spring2018.pdf
[21] "Earth and Environmental Engineering Doctorate Degree." Columbia University. https://cvn.columbia.edu/program/columbia-university-earth-and-environmental-engineering-doctorate-degree-doctor-engineering
[22] "Graduate Admissions." Armour College of Engineering Illinois Institute of Technology. https://admissions.iit.edu/graduate/programs/armour-college-engineering
[23] IPEDS
[24] "Programs." College of Engineering Mississippi State University. http://www.bagley.msstate.edu/distance/programs/
[25] "Degrees Awarded."
[26] "Online Programs & Courses." University of Alabama Huntsville. https://www.uah.edu/online-learning/online-programs
[27] "University Facts." University of Alabama Huntsville. https://www.uah.edu/academic-affairs/offices/oira/university-facts
[28] "Distance Education," Op. cit.
[29] IPEDS

Remarkably, enrollment in FSU-FAMA's PhD in Civil Engineering program has almost tripled over the past five years. However, FAU's closest competitor, FIU, has seen a significant enrollment decrease since 2013. These enrollment trends suggest student demand varies from year to year and program to program. The same can be said of the three environmental engineering PhD programs in the state. USF's program, for instance, has doubled enrollments over the past five years. While UCF and UF has seen some slight decreases. However, across the entire University System, **PhD enrollments have remained steady over the past five years for both civil and environmental engineering, suggesting student demand is consistent.**

In terms of enrollment volume, all universities except for the University of Miami, enrolled *at least* 33 students across their civil and environmental engineering PhD programs in 2017. Assuming students are completing these programs within five to six years, this confirms that FAU's goals of enrolling 7 to 10 students in the first year and five students per year thereafter would be feasible.

Figure 3.3: Enrollment in Advanced Graduate Programs in Civil and Environmental Engineering in the University System of Florida*

Institution	2013	2014	2015	2016	2017	CAGR
Civil Engineering						
Florida International University	71	74	65	58	50	-8.4%
Florida State University-FAMU	16	21	23	27	33	19.8%
University of Central Florida	58	70	67	69	84	9.7%
University of Florida	69	64	69	69	65	-1.5%
University of South Florida	57	48	46	50	54	-1.3%
University of Miami**	18	16	17	15	16	-2.9%
Total	**289**	**293**	**287**	**288**	**302**	**1.1%**
Environmental Engineering						
University of Central Florida	13	17	15	10	12	-7.7%
University of Florida	52	47	45	49	42	-19.2%
University of South Florida	12	16	15	20	25	108.3%
Total	**77**	**80**	**75**	**79**	**79**	**0.6%**

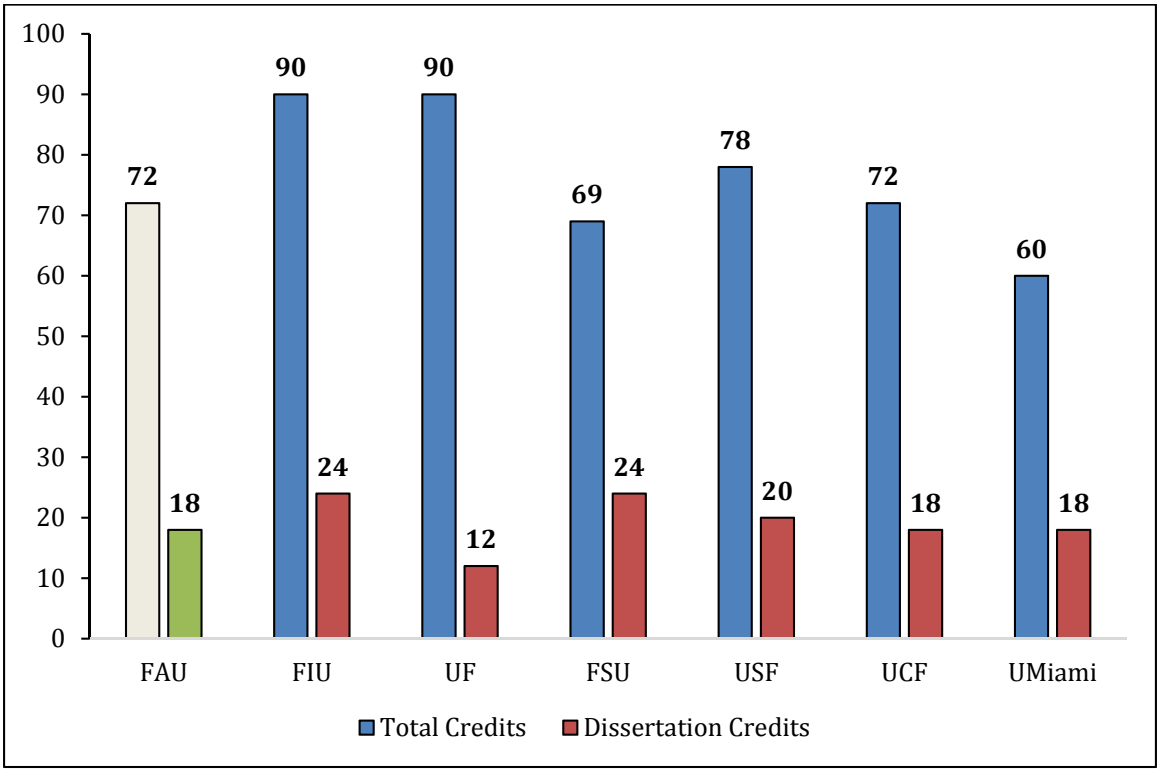
Source: SUS Board of Governors and University of Miami[30]
*Note that the Florida Board of Governors defines "advanced graduate" as equivalent to the doctoral level
** University of Miami is a private institution outside the SUS.

[30] [1] "Fall Student Enrollment in State University System Institutions." State University System of Florida Board of Governors, 2018. http://www.flbog.edu/resources/iud/enrollment_search.php
[2] "Fall 2017 Fact Book." Office of Planning, Institutional Research, and Assessment, University of Miami, 2017. p. 52. https://pira.miami.edu/_assets/pdf/FactBook.pdf

Core Curriculum

Compared to other civil and environmental engineering PhD programs in the state, FAU's proposed total credits beyond the bachelor's degree (72 credits) are slightly lower than the competitor average (76.5 credits). FAU's proposed dissertation credits (18 credits) are also just below the competitor average (19.3 credit hours). A detailed comparison is shown in Figure 3.4.

Figure 3.4: Comparison of Competitor Credit Requirements to FAU's Proposed Curriculum



Source: Institutional Websites
Note: Total credits hours are beyond the baccalaureate degree.

FAU's proposed core requirements are similar to requirements across competitors, as shown in Figure 3.5. However, most competitor programs do *not* require publication submission, whereas FAU's curriculum does. FSU and USF are the other two PhD programs that explicitly require a publication submission. FAU should also consider if its proposed program will have a time limit for students to complete a dissertation defense after the qualifying exam and admission to candidacy. The University of Florida sets a time limit of five years for this, while Florida International University extends it to seven years.

Figure 3.5: Comparison of Competitor Core Requirements

Institution	Qualifying Exam	Must Choose Specialization	Publication Requirement	Dissertation Proposal Defense	Dissertation Defense	Time Limits
Florida Atlantic University	✓	X	✓	✓	✓	N/A
Florida International University	✓	✓	X	✓	✓	7 years
University of Florida	✓	✓	X	X	✓	5 years
University of Central Florida	✓	✓	X	✓	✓	Unknown
University of Miami	✓	X	X	✓	✓	Unknown
Florida State University	✓	✓	✓	✓	✓	Unknown
University of South Florida	✓	✓	✓	✓	✓	Unknown

Source: Institutional Websites
Note: Dissertation Defense includes both the written requirement and the oral defense.

Appendix I: Methodology

Degree Completions Methodology

To assess trends in student demand, Hanover analyzes the five most recent years of conferral data available through the National Center for Education Statistics. If conferrals for a particular field at a particular level have been increasing over time, it can be inferred that student demand for that type of degree is on the rise.

The NCES uses a taxonomic system of numeric codes to classify higher education programs, known as the Classification of Instructional Programs (CIP). All institutions of higher education submit degree conferrals annually, sorted by award level and CIP code, to the NCES' Integrated Postsecondary Education Data System (IPEDS).[31] Figure A.1 displays the CIP codes used in this analysis that are related to civil and environmental engineering.

[31] Unless otherwise noted, all degree completions data analyzed in this report are drawn from "Integrated Postsecondary Education Data System Data Center." National Center for Education Statistics. http://nces.ed.gov/ipeds/datacenter/

Figure A.1: Civil and Environmental Engineering Related CIP Codes

CIP Code and Title	CIP Description
14.0801: Civil Engineering, General	A program that generally prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of structural, load-bearing, material moving, transportation, water resource, and material control systems; and environmental safety measures
14.0802: Geotechnical and Geoenvironmental Engineering	A program that prepares individuals to apply geotechnical engineering methods, which deal with the analysis, design and construction of earth and earth supported structures, to the application of environmental problems, such as waste containment, waste disposal, construction of land fills, soil permeation, soil analysis, and soil improvement. Includes instruction in soil mechanics, soil dynamics, soil behavior, waste management and containment systems, geosynthetics, geochemistry, earth structures, geoenvironmental engineering, geotechnical engineering, earthquake engineering, and foundation engineering
14.0803 Structural Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of materials and systems used in building load-bearing structures for various purposes and in different environments, including buildings, roads, rail lines, bridges, dams, conduits, offshore platforms and work stations, and other structural shells; and the analysis of structural problems such as, failure, fabrication, safety, and natural hazards.
14.0804 Transportation and Highway Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of total systems for the physical movement of people, materials and information, including general network design and planning, facilities planning, site evaluation, transportation management systems, needs projections and analysis, and analysis of costs.
14.0805 Water Resources Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for collecting, storing, moving, conserving and controlling surface- and groundwater, including water quality control, water cycle management, management of human and industrial water requirements, water delivery, and flood control.
14.0899 Civil Engineering, Other	Any instructional program in civil engineering not listed above.
14.1401 Environmental/Environmental Health Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for controlling contained living environments and for monitoring and controlling factors in the external natural environment, including pollution control, waste and hazardous material disposal, health and safety protection, conservation, life support, and requirements for protection of special materials and related work environments.
14.1801 Materials Engineering	A program that prepares individuals to apply mathematical and materials science principles to the design, development and operational evaluation of materials and related processes used in manufacturing in a wide variety of settings; the synthesis of new industrial materials, including marrying and bonding composites; analysis of materials requirements and specifications; and related problems of system design dependent on materials factors.

CIP Code and Title	CIP Description
14.3301 Construction Engineering	A program that prepares individuals to apply scientific, mathematical, and management principles to the planning, design, and building of facilities and structures. Includes instruction in civil engineering, structural principles, site analysis, computer-assisted design, geology, evaluation and testing, materials, contracting, project management, graphic communications, and applicable laws and regulations.
14.3801 Surveying Engineering	A program that prepares individuals to apply scientific and mathematical principles to the determination of the location, elevations, and alignment of natural and manmade topographic features. Includes instruction in property line location, surveying, surface measurement, aerial and terrestrial photogrammetry, remote sensing, satellite imagery, global positioning systems, computer applications, and photographic data processing.
14.3901 Geological/Geophysical Engineering	A program that prepares individuals to apply mathematical and geological principles to the analysis and evaluation of engineering problems, including the geological evaluation of construction sites, the analysis of geological forces acting on structures and systems, the analysis of potential natural resource recovery sites, and applied research on geological phenomena.
14.4401 Engineering Chemistry	A program that focuses on the general application of chemical principles to the analysis and evaluation of engineering problems, such as development of electronic materials, solid-state science and technology, polymers, ceramics, and biomaterials. Includes instruction in physical chemistry, organic chemistry, materials science, chemical processes and systems, chemical reaction engineering, biochemical engineering, engineering mathematics, classical and modern physics, and computer science.
14.4501 Biological/Biosystems Engineering	A program that prepares individuals to apply mathematical and scientific principles to the design, development and management of biological systems; and includes applications to biology, biochemistry, ecology, and microbiology. Includes instruction in organic chemistry; microbiology; biochemistry; chemical, biological, biochemical, and process engineering; thermodynamics; process control; kinetics and reactor design; electric circuits; biosystem modeling; and bioelectronics and instrumentation

Source: NCES[32]

When interpreting completions data, some considerations should be taken into account:

- Institutions classify their programs independently, meaning that two programs that share identical content could hypothetically be classified under different CIP codes. Also, for any given institution it cannot be assumed that IPEDS completions data for an individual CIP classification always correspond directly to an individual program. To counter this, Hanover uses a variety of potentially relevant CIP codes to assess student demand.
- Newer programs may be excluded from completions data, as these programs will not have graduated students yet. For this reason, we include enrollments data as well.

[32] "CIP 2010 Search." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/search.aspx?y=55

- 2016 data are in provisional release only and have yet to undergo final NCES verification procedures.

Labor Projections Methodology

Similar to the CIP classification system developed by the NCES, the Bureau of Labor Statistics maintains its own classification system for occupations using Standard Occupational Classification (SOC) codes. To identify relevant occupations associated with each academic program, Hanover consulted a crosswalk provided by the NCES that links CIP codes with SOC codes.[33] Figure A.2 provides descriptions for selected SOC codes related to degrees in civil and environmental engineering.

Figure A.2: Civil and Environmental Engineering Related SOC Codes

SOC Code and Title	SOC Description
11-9041 Architectural and Engineering Managers	Plan, direct, or coordinate activities in such fields as architecture and engineering or research and development in these fields.
17-1021 Cartographers and Photogrammetrists	Collect, analyze, and interpret geographic information provided by geodetic surveys, aerial photographs, and satellite data. Research, study, and prepare maps and other spatial data in digital or graphic form for legal, social, political, educational, and design purposes. May work with Geographic Information Systems (GIS). May design and evaluate algorithms, data structures, and user interfaces for GIS and mapping systems.
17-1022 Surveyors	Make exact measurements and determine property boundaries. Provide data relevant to the shape, contour, gravitation, location, elevation, or dimension of land or land features on or near the earth's surface for engineering, mapmaking, mining, land evaluation, construction, and other purposes.
17-2041 Chemical Engineers	Design chemical plant equipment and devise processes for manufacturing chemicals and products, such as gasoline, synthetic rubber, plastics, detergents, cement, paper, and pulp, by applying principles and technology of chemistry, physics, and engineering.
17-2051 Civil Engineers	Perform engineering duties in planning, designing, and overseeing construction and maintenance of building structures, and facilities, such as roads, railroads, airports, bridges, harbors, channels, dams, irrigation projects, pipelines, power plants, and water and sewage systems. Includes architectural, structural, traffic, ocean, and geo-technical engineers.
17-2081 Environmental Engineers	Research, design, plan, or perform engineering duties in the prevention, control, and remediation of environmental hazards using various engineering disciplines. Work may include waste treatment, site remediation, or pollution control technology.
17-2111 Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	Promote worksite or product safety by applying knowledge of industrial processes, mechanics, chemistry, psychology, and industrial health and safety laws. Includes industrial product safety engineers.

[33] "CIP 2010 Search." National Center for Education Statistics. http://nces.ed.gov/ipeds/cipcode/search.aspx?y=55

SOC Code and Title	SOC Description
17-2112 Industrial Engineers	Design, develop, test, and evaluate integrated systems for managing industrial production processes, including human work factors, quality control, inventory control, logistics and material flow, cost analysis, and production coordination.
17-2121 Marine Engineers and Naval Architects	Design, develop, and evaluate the operation of marine vessels, ship machinery, and related equipment, such as power supply and propulsion systems.
17-2131 Materials Engineering	Evaluate materials and develop machinery and processes to manufacture materials for use in products that must meet specialized design and performance specifications. Develop new uses for known materials. Includes those engineers working with composite materials or specializing in one type of material, such as graphite, metal and metal alloys, ceramics and glass, plastics and polymers, and naturally occurring materials. Includes metallurgists and metallurgical engineers, ceramic engineers, and welding engineers.
17-2151 Mining and Geological Engineers, Including Mining Safety Engineers	Conduct sub-surface surveys to identify the characteristics of potential land or mining development sites. May specify the ground support systems, processes and equipment for safe, economical, and environmentally sound extraction or underground construction activities. May inspect areas for unsafe geological conditions, equipment, and working conditions. May design, implement, and coordinate mine safety programs.
19-1031 Conservation Scientists	Manage, improve, and protect natural resources to maximize their use without damaging the environment. May conduct soil surveys and develop plans to eliminate soil erosion or to protect rangelands. May instruct farmers, agricultural production managers, or ranchers in best ways to use crop rotation, contour plowing, or terracing to conserve soil and water; in the number and kind of livestock and forage plants best suited to particular ranges; and in range and farm improvements, such as fencing and reservoirs for stock watering.
19-2041 Environmental Scientists and Specialists, Including Health	Conduct research or perform investigation for the purpose of identifying, abating, or eliminating sources of pollutants or hazards that affect either the environment or the health of the population. Using knowledge of various scientific disciplines, may collect, synthesize, study, report, and recommend action based on data derived from measurements or observations of air, food, soil, water, and other sources.
19-2042 Geoscientists, Except Hydrologists and Geographers	Study the composition, structure, and other physical aspects of the Earth. May use geological, physics, and mathematics knowledge in exploration for oil, gas, minerals, or underground water; or in waste disposal, land reclamation, or other environmental problems. May study the Earth's internal composition, atmospheres, oceans, and its magnetic, electrical, and gravitational forces. Includes mineralogists, crystallographers, paleontologists, stratigraphers, geodesists, and seismologists.
19-2043 Hydrologists	Research the distribution, circulation, and physical properties of underground and surface waters; and study the form and intensity of precipitation, its rate of infiltration into the soil, movement through the earth, and its return to the ocean and atmosphere.

SOC Code and Title	SOC Description
25-1032 Engineering Teachers, Postsecondary	Teach courses pertaining to the application of physical laws and principles of engineering for the development of machines, materials, instruments, processes, and services. Includes teachers of subjects such as chemical, civil, electrical, industrial, mechanical, mineral, and petroleum engineering. Includes both teachers primarily engaged in teaching and those who do a combination of teaching and research.
25-1053 Environmental Science Teachers, Postsecondary	Teach courses in environmental science. Includes both teachers primarily engaged in teaching and those who do a combination of teaching and research.
41-9031 Sales Engineers	Sell business goods or services, the selling of which requires a technical background equivalent to a baccalaureate degree in engineering.

Source: BLS[34]

[34] "Standard Occupational Classification (SOC) System." Bureau of Labor Statistics. https://www.bls.gov/soc/

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APPENDIX E

1. Name

Madasamy Arockiasamy, Ph.D., P.E., P. Eng., Fellow ASCE
Professor & Director, Center for Infrastructure and Constructed Facilities
Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D. Civil Engineering, Structures Emphasis
University of Wisconsin, Madison, 1971

M.Sc. Civil Engineering, Structures Emphasis
University of Madras, India, 1963

B.E.(Hons.), Civil Engineering,
University of Madras, India, 1960.

3. Academic experience

2000 – present	Professor and Director, Center for Infrastructure and Constructed Facilities, Department of Civil Engineering, FAU
1986 – 2000	Professor and Director, Center for Infrastructure and Constructed Facilities, Department of Ocean/Civil Engineering, FAU
1984 – 1986	Associate Professor, Department of Ocean Engineering, FAU
1981- 1985	Associate Professor, Faculty of Engineering and Applied Science, Memorial University of Newfoundland, St. John's, Newfoundland
1976 – 1981	Professor of Structural Engineering, Anna Technical University, Madras
1960 - 1976	Assistant Professor / Lecturer / Associate Lecturer, College of Engineering, Guindy, Madras,

4. Non-academic experience

1980-1981 Research/Project Engineer, Giffels Associates, Detroit, MI

5. Certifications or professional registrations

Registered Professional Engineer
Florida (Active) License # 34781
Louisiana (Inactive)
Alabama (Inactive)
Wisconsin (Inactive)
Newfoundland, Canada (Inactive)

6. Current membership in professional organizations

- American concrete Institute since 1984
- Tau Beta Pi, member since 1970
- American Society of Civil Engineers member since 1971
- American National Standards Institute since 2012

7. Honors and awards

- Distinguished Engineering Educator of the Year Award, The Engineer's Council, 2015
- State University System (SUS) Professorial Excellence Program (PEP) award, December 1998.
- "Best Accent" Teacher Award, College of Engineering, March 1995.

- Elected as Eminent Engineer of the Florida Epsilon Chapter of Tau Beta Pi, November 1994.
- Nominated for the Award for University Research Professor from the College of Engineering, 1996.
- Outstanding Achievement Award, College of Engineering, Florida Atlantic University, 1990.
- Nominated for Distinguished Teacher of the Year 1985-86, Department of Ocean Engineering

8. Service activities (within and outside of the institution)

- President of the College of Engineering and Computer Science (2018–Present)
- Chair, College Policy and Development Committee
- Tau Beta Pi Engineering Honor Society (1994-1997)
- Co-ordinator, Florida Structural Engineering Association (FSEA) Scholarships Committee, Department of Civil, Environmental and Geomatics Engineering (2005-present)
- FAU Faculty Advisor, ASCE Chapter, College of Engineering and Computer Science Faculty Liaison (2017 – Present)
- Editor-in-Chief, International Journal of Innovative Research in Infrastructure Engineering 2014-present
- Member, Editorial Board, Journal of Shipping and Ocean Engineering (2013-present)
- Member, Editorial Board, Journal of Energy and Power Engineering (2013-present)
- Subject Matter Expert, International Electrotechnical Commission IEC TC114 (2011 – Present)

8. Selected publications

- S. Ishwarya, S.K. Raju Alluri, K. Balakrishnan, M.V. Ramana Murthy, and **M. Arockiasamy**, "Simplified Design Procedure of Monopile Foundation for Offshore Wind Turbine in Gujarat, India", Journal of Shipping and Ocean Engineering, Vol.7, Number 4, July-Aug.2017 (Serial Number 32), pp.133-151.
- X.Yang, **M. Arockiasamy**, A. Mirmiran, and W. Potter, "High Creep Stress Test of Carbon Fiber Composite Cable with Generic Field-Made Anchorage", Technical Note, ASCE Journal of Composites for Construction, ASCE, ISSN 1090-0268, March 2017.
- S. Ishwarya, **M. Arockiasamy**, and R. Senthil, "Inelastic Nonlinear Pushover Analysis of Fixed Jacket-Type Offshore Platform with Different Bracing Systems Considering Soil-Structure Interaction", Journal of Shipping and Ocean Engineering, Vol.6, No. 4, July-Aug. 2016.
- X.Yang, P. Zohrevand, A. Mirmiran, **M. Arockiasamy**, and W. Potter, "Comparative Study of Un-bonded Carbon Fiber and Steel Strands in Post-tensioned Pier Caps", ASCE Journal of Composites for Construction, 10.1061/(ASCE)CC.1943-5614.0000596,04015042, June 2015.
- X.Yang, P. Zohrevand, A. Mirmiran, **M. Arockiasamy**, and W. Potter, "Post-tensionong of Segmental Bridges Using Carbon-fiber Composite Cables", PCI Journal, May-June 2015, Vol. 60, No.3, pp. 50-61.

1. Name

Frederick Bloetscher, Ph.D., P.E.
Assoc. Dean for Undergrad Studies and Community Outreach
Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D. in Civil Engineering
University of Miami, 2001
Master of Public Administration
University of North Carolina at Chapel Hill, 1984
Bachelor of Science, Civil Engineering
University of Cincinnati, 1982

3. Academic experience

2005 - present: Florida Atlantic University – Associate Dean for Undergraduate Studies and Community Outreach, (July 2018 – date), Professor (August 2017 – date), Associate Professor (August 2011-August 2017), Assistant Professor (August 2005 to August 2011), Department of Civil Engineering (Adjunct Professor in August, 2004 to August, 2005)

2001 - 2005: University of Miami – Adjunct Faculty, Department of Civil, Architectural and Environmental Engineering.

4. Non-academic experience

2000 - present: President and owner, Public Utility Management and Planning Services Inc.
1999 - 2000: Dir. of Engineering, Operations and Planning, Florida Governmental Utility Authority
1994 - 1999: Deputy Public Utilities Director, City of Hollywood, FL
1989 - 1994: Assistant Utilities Administrator, Collier County, FL
1986 - 1989: Town Administrator/Director of Public Works, Richlands, NC
1985 - 1986: Town Manager, Erwin, NC; Chief Executive Officer
1983 - 1985: Utilities Civil Engineer, Public Utilities Department, City of Jacksonville, NC

5. Certifications or professional registrations

- Professional Engineer's License (North Carolina, Georgia, Florida, South Carolina, Utah, Colorado, Tennessee, Michigan and Ohio).
- North Carolina General Contractor's License (Public Utilities - #22775)
- LEED - AP
- Grade A Water Distribution System Certificate (North Carolina - #4138)
- Grade B Water Plant Operator's Certificate (North Carolina - #4138)
- Grade III Water Pollution Control Operator's Certificate (North Carolina - #8967)
- Grade 4 Collection System Operator's Certificate (North Carolina - # 13150)

6. Current membership in professional organizations

American Water Works Association, Florida Engineering Society, Water Environment Federation, American Society of Civil Engineers

7. Honors and awards

- Presidential Award for Community Outreach – Florida Atlantic University
- Change Agent of the Year Faculty Award, FAU, 2017
- Distinguished Educator of the Year Award, Engineers, Council, 2017
- Alan B. Robertson Award, FSAWWA 2015.
- Florida Engineering Society Broward –Technical Service Award - 2015
- FSAWWA Executive Committee Award - 2014
- Oasis Award – AWWA – 2014
- NCEES Student Profession Partnership Grand Award, 2012
- Talon Faculty Award for Leadership – Florida Atlantic University, 2012
- Volunteer of the Year Award, American Water Works Association (inaugural), 2011
- Robert Claudy Award, Florida Section, American Water Works Association, 2011
- TIAA-CREF Leadership Award, Florida Atlantic University, 2010
- Best Paper Award – FSAWWA Annual Conference 2006, 2008, 2010, 2015, 2016, 2018
- MAC Council Best Chair Award (Chair of Technical Program FSAWWA conference), 2006

8. **Service activities** (within and outside of the institution)

Graduate	Chair through July, 2018
Math Committee	Fall 18-date
Graduate Committee	through July 2018
Graduate Policy Committee	member
Writing Across the Curriculum Committee	Chair Fall 18, member
FSAWWA Technical Program Committee	Chair
Florida Section AWWA	Vice Chair
Groundwater (AWWA National)	Chair
Distribution Design and Construction (AWWA)	Chair
Technical and Education Council	Through June 2018

9. **Selected publications**

- **Bloetscher, F.** 2019. Using Predictive Bayesian Monte Carlo- Markov Chain Methods To Provide A Probablistic Solution For The Drake Equation, *Acta Astronautica*, Volume 155, p. 118-130.
- **Bloetscher, F.** 2018. Risk and Economic Development in the Provision of Public Infrastructure, *Journal of Environmental Protection*, Vol.09, No.09. 10.4236/jep.2018.99061.
- **Bloetscher, F.**, Wander, L., Smith, G. and Dogon, N. 2017. Public Infrastructure Asset Assessment with Limited Data. Open Journal of Civil Engineering, Vol.07 No.03, 10.4236/ojce.2017.73032.
- **Bloetscher, *F.*** and *Wood*, M. 2016. Assessing the Impacts of Sea Level Rise Using Existing Data, *Journal of Geoscience and Environment Protection*, Vol.04, No.09. 10.4236/gep.2016.49012.
- **Bloetscher, F.**; Colin Polsky, William Schnabel, Billy Connor. 2016. Assessing Climate Vulnerability in Disparate Places–Alaska and South Florida. *Climate Change,* 2(8), 526-550.
- **Bloetscher, F.**; Sham, Chi Ho, Ratick, S. and Danko III, J.J. 2015. Status of Aquifer Storage and Recovery In The United States – 2013**,** *British Journal of Science* 70 April 2015, Vol. 12 (2).
- **Bloetscher, F.**; Polsky, C.; Bolter, K.; Mitsova, D.; Pablicke Garces, K.; King, R.; Cosio Carballo, I.; and Hamilton, K. 2016. Assessing Potential Impacts of Sea Level Rise on Public Health and Vulnerable Populations in Southeast Florida and Providing a Framework to Improve Outcomes, *Sustainability*, 8, 315; doi:10.3390/su8040315.
- Englehardt, J.D.; Uu, T.; **Bloetscher, F.**; Deng, Y.; Pisani, P.; Eilert, S.; Elmir, S.; Guo, T.; Jacangelo, J.; LeChevallier, M.; Leverenz, H.; Mancha, E.; Plater-Zyberk, E.; Sheikh, B.; Steinle-Darling, and Tchobanoglous, G. 2015, Net-Zero Water Management: Achieving Energy-Positive Municipal Water Supply, *Environmetnal Science - Water Research & Technology*.

1. Name

Jinwoo Jang, Ph.D.
Assistant Professor, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University
Faculty Fellow, Institute for Sensing & Embedded Network Systems Engineering, Florida Atlantic University

2. Education

Ph.D. in Civil Engineering and Engineering Mechanics
Columbia University, New York, NY (October 2016)

Master of Philosophy in Civil Engineering and Engineering
Columbia University, New York, NY (October 2013)

Master of Science in Civil Engineering and Engineering
Columbia University, New York, NY (February 2011)

Bachelor of Engineering in Civil and Environmental Engineering
Kookmin University, Seoul, South Korea (February 2009)

3. Academic experience

2017 – present	Assistant Professor, Department of Civil, Environmental & Geomatics Engineering, FAU
2017 – present	Faculty Fellow, Institute for Sensing & Embedded Network Systems Engineering, FAU
2016 – 2017	Postdoctoral Research Scientist, Department of Civil Engineering and Engineering Mechanics, Columbia University
2013 – 2016	Staff Associate, Department of Civil Engineering and Engineering Mechanics, Columbia University

4. Non-academic experience

2014	Research Intern, Philips Research North America, Cambridge, Massachusetts

5. Certifications or professional registrations

N/A

6. Current membership in professional organizations

- American Society of Civil Engineers (ASCE)
- Engineering Mechanics Institute (EMI)
- Korean-American Scientists and Engineering Association (KSEA)

7. Honors and awards

- Best demo award, Data Science Day, Columbia University, NY, April 2018
- First Place in Dynamics Student Paper Competition, ASCE Engineering Mechanics Institute Conference, Stanford University, CA, June 2015
- Poster Award, US-Korea Conference (UKC), Atlanta, GA, June 2015
- Full Tuition Waiver, Columbia University, NY, September 2011 - May 2012

- Academic Scholarship, Kookmin University, South Korea, March 2006 - December 2007
- Academic First Place, National Center Police Academy, South Korea, December 2002

8. Service activities (within and outside of the institution)

- Member, Structural Health Monitoring Committee, American Society of Civil Engineers
- Engineering Mechanics Institute (2017–Present)
- Member, Dynamics Committee, American Society of Civil Engineers Engineering Mechanics
- Institute (2017–Present)
- Member, Department of Civil, Environmental and Geomatics Engineering
- Undergraduate Committee (2017–Present)
- Member, College of Engineering and Computer Science Undergraduate Committee
- (2018–Present)

9. Selected publications

- Bartilson D. T., **Jang, J.**, and Smyth, A. W. (2019). "Finite element model updating using objective- consistent sensitivity-based parameter clustering and Bayesian regularization." Mechanical Systems and Signal Processing. 114: 328-345. doi: 10.1016/j.ymssp.2018.05.024
- **Jang, J.**, and Smyth, A. W. (2017)."Bayesian model updating of a full-scale finite element model with sensitivity-based clustering." Structural Control and Health Monitoring. 24(11): e2004. doi: 10.1002/stc.2004
- **Jang, J.**, and Smyth, A. W. (2017). "Model updating of a full-scale FE model with nonlinear con- straint equations and sensitivity-based cluster analysis for updating parameters." Mechanical Systems and Signal Processing. 83(15): 337-355. doi:10.1016/j.ymssp.2016.06.018
- **Jang, J.**, Yang, Y., Smyth, A. W., Cavalcanti, D., and Kumar, R. (2016). "Framework of data acquisition and integration for the detection of pavement distress via multiple vehicles." Journal of Computing in Civil Engineering. 31(2). doi: 10.1061/(ASCE)CP.1943-5487.0000618
- **Jang, J.**, Smyth, A. W., Yang, Y., and Cavalcanti, D. A. T. (2015). "Road surface condition monitor- ing via multiple sensor-equipped vehicles." IEEE INFOCOM. 43-44. Hong Kong. doi: 10.1109/INF- COMW.2015.7179334

1. Name

Evangelos I. Kaisar, Ph.D.,
Professor & Director, Geomatics and Transportation Engineering Program,
Director, Freight Mobility Research Institute (FMRI)
Department of Civil, Environmental & Geomatics Engineering,
Florida Atlantic University

2. Education

Ph.D. in Civil Engineering, Transportation & Logistics Emphasis
University of Maryland of College Park, 2005

Master of Science in Civil Engineering, Transportation & Logistics Emphasis
University of Maryland of College Park, 2000

Bachelor of Science in Civil Engineering, Transportation & Logistics Emphasis
University of Maryland of College Park, 1998

3. Academic experience

2017 – present	Professor, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
2017 – present	Director, Freight Mobility Research Institute (FMRI)
2012 – 2017	Associate Professor with tenure, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
2009 – present	Director, Multimodal Intelligent Systems Laboratory
2006-2012	Assistant Professor, Department of Civil Engineering, College of Engineering and Computer Science, FAU
2000-2005	Doctoral Research Fellow, University of Maryland of College Park

4. Non-academic experience

2005-2006 Maryland Transportation Authority, (MdTA)

5. Certifications or professional registrations

6. Current membership in professional organizations

- Transportation Research Board, member since 2000
- ITE, member since 1999
- American Society of Civil Engineers, member since 1999

7. Honors and awards

- Florida Atlantic University, Researcher of the Year Award, 2017
- Featured in the Who's Who in Science and Engineering 2011-2012 (11th Edition).
- Florida Atlantic University Excellence and Innovation in Undergraduate Teaching Award, 2013.
- Best paper award at the Spring Simulation Interoperability Workshop, San Diego, CA, March, 2009.

8. Service activities (within and outside of the institution)

- *College of Engineering and Computer Science Research Committee Chair* (2018–Present)
- Faculty Advisor. ITE Student Chapter (2000 – Present)

- FAU Honors and Awards Committee Chair (2012 – Present)

9. Selected publications

- Charisis A., **Kaisar E.,** Mitrovic N., and Papadimitriou S., "Containership Routing with Multiple Time Windows and Excessive Demand Consideration", Journal, maritime Economics and Logistics (MEL), exp. June 2019.
- Soltani-Sobh A., Heaslip K., Scarlatos P., and **Kaisar E.,** "Reliability Based Pre-Positioning of Recovery Centers for Resilient Transportation Infrastructure", International Journal of Disaster Risk Reduction, Volume 19, pp 324-333, Oct. 2016.
- **Kaisar E.,** Coolahan J., Koomullil R., and Averkiou P., "Infectious Disease and Hospital Surge Capacity Impacts on Urban Transportation", International Journal of Transportation, Vol 4, No. 2, pp-15-30, Aug. 2016.
- Stevanovic A., Olarte C., Galletebeitia A., Galletebeitia B., and **Kaisar E.**, "Testing Accuracy and Reliability of MAC Readers to Measure Arterial Travel Times", Journal of International intelligent Transportation System Research, Vol. 13, Issue 1, pp-5-10, 2015.
- Zhao Y**.** and **Kaisar E.,** "Modeling and Simulation on Yard Trailers in a Maritime Terminal", Journal of Logistics Engineering and Management, Vol. IC, pp 12-21, Dec. 2014.
- Parr S., **Kaisar E.,** and Stevanovic A., "Applications of Transit Signal Priority for No-Notice Urban Evacuation", ASCE, Natural Hazards Rev. 10.1061, June 2013.
- Golias M.M., Portal M.I., Konur D., **Kaisar E.,** and Kolomvos G., "Robust Berth Scheduling at Marine Container Terminals via Hierarchical Optimization." Journal of Computers and Operations Research, art. Number: 3378, 2013.
- Stevanovic, A.Z., Kergaye, C., and **Kaisar, E.** "Field Evaluation of Signal Timings Developed by a Stochastic Signal Optimization Tool." Journal of Road and Traffic Engineering – Journal of the Road Association of Serbia "Via Vita", No. 1 pp. 5-11, Dec. 2012.
- **Kaisar E.,** Hess L., and Portal-Palomo A.B., "An Emergency Evacuation Planning Model for Vulnerable Population Utilizing Public Transportation Systems" Journal of Public Transportation Vol. 15, No. 2, pp. 45-70, Dec. 2012.

1. Name

Daniel E. Meeroff, Ph.D., E.I.
Professor & Associate Chair, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University
Director, Laboratories for Engineered Environmental Solutions (Lab.EES)

2. Education

Ph.D. in Civil Engineering, Environmental Engineering Emphasis
University of Miami, Coral Gables, FL, December 2001

Master of Science in Civil Engineering, Environmental Engineering Emphasis
University of Miami, Coral Gables, FL, August 1997

Bachelor of Science in Environmental Science
Florida Institute of Technology, Melbourne, FL, May 1995

3. Academic experience

2013 – present Associate Chair & Professor, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
2008 – 2013 Associate Professor with tenure, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
2003 – present Director, Laboratories for Engineered Environmental Solutions
2003-2008 Assistant Professor, Department of Civil Engineering, College of Engineering and Computer Science, FAU
2001 – 2003 Adjunct Professor/Instructor/Post-Doctoral Research Fellow, Department of Civil, Architectural, and Environmental Engineering, University of Miami
1997-2001 Doctoral Research Fellow, University of Miami, Coral Gables, FL

4. Non-academic experience

2000 Engineering Consultant, Montgomery Watson, Sunrise, FL
1999-2000 Consultant, Florida Governmental Utility Authority, Tallahassee, FL

5. Certifications or professional registrations

Engineer Intern. State of Florida Board of Professional Engineers.
License #: 1100003721 (September 1998).

6. Current membership in professional organizations

- Florida Water Environment Association, member since 1995
- Tau Beta Pi, member since 1998
- Water Environment Federation, member since 1995

7. Honors and awards

- Distinguished Engineering Educator of the Year Award, The Engineer's Council, 2019
- Florida Atlantic University Excellence and Innovation in Undergraduate Teaching Award, 2017
- Florida Atlantic University Distinguished Research Mentor of the Year, 2015
- John J. Guarrera Engineering Educator of the Year Award, The Engineer's Council, 2014
- Florida Atlantic University Distinguished Teacher of the Year, 2014
- Quality Matters Seal of Recognition for eLearning, EGN2095-Engineering Chemistry, 2013

- NCEES Engineering Award $25,000 Winner, Dania Beach Nanofiltration Plant Expansion, 2012
- Florida Atlantic University Excellence and Innovation in Undergraduate Teaching Award, 2011
- Florida Tech Sports Hall of Fame Inductee, 2008
- FAU Researcher of the Year Award Nominee (Assistant Professor Level), 2006
- Florida Atlantic University College of Engineering Dean's Award, 2004
- Florida Water Environment Association, Service Award, 2004, 2005, 2006, 2007
- WEF Student Paper Competition, Masters Category, 1998

9. Service activities (within and outside of the institution)

- College of Engineering and Computer Science Undergraduate Committee Chair (2013–Present)
- Faculty Advisor. Tau Beta Pi Engineering Honor Society (2005 – Present)
- Faculty Advisor. Florida Water Environment Association Student Chapter (2003 – Present)
- FAU Community Engagement Task Force, College of Engineering and Computer Science Faculty Liaison (2017 – Present)
- FAU Undergraduate Programs Committee (2013 – Present)
- FAU Quality Enhancement Plan Steering Committee and College of Engineering and Computer Science Faculty Liaison (2011 – Present)
- FAU eLearning Steering Committee Member (2011 – Present)
- Co-chair, National Pollution Prevention Roundtable Sustainable Hospitality Research Workgroup (2011 – present).

10. Selected publications

- Bloetscher, F., **D.E. Meeroff**, Roblyer, J., & Prymas, A. (2018). Algal Control in Warm Weather Pond Using EMOH Device. Journal of Environmental Protection, 9(08), 882-894.
- Bloetscher, F., & **D.E. Meeroff** (2015). Practical concepts for capstone design engineering. J Ross Publishing.
- Carsey, T., Stamates, J., Zhang, J. Z., Bloetscher, F., **D.E. Meeroff**, & Featherstone, C. (2015). Point Source Nutrient Fluxes from an Urban Coast: The Boynton (Florida) Inlet. Environment and Natural Resources Research, 5(2), 121-134.
- **D.E. Meeroff**, F. Bloetscher, S.C. Long, and T. Bocca (2014). "The Use of Multiple Tracers to Evaluate the Impact of Sewered and Non-Sewered Development on Coastal Water Quality in a Rural Area of Florida." Water Environment Research, Volume 86, Number 5, 445-456.
- **D.E. Meeroff**, F. Bloetscher, D. V. Reddy, F. Gasnier, S. Jain, A. McBarnette and H. Hamaguchi (2012). "Application of photochemical technologies for treatment of landfill leachate," Journal of Hazardous Materials, Volume 209–210, pp. 299–307.

1. Name

Sudhagar Nagarajan, Ph.D.
Assistant Professor, College of Engineering and Computer Science, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D. in Civil, Environmental Engineering and Geodetic Science
The Ohio State University, Columbus, OH, March 2010

M.S. in Civil, Environmental Engineering and Geodetic Science
The Ohio State University, Columbus, OH, December 2008

M.S. in Photogrammetry and Geoinformatics
Stuttgart University of Applied Sciences, March 2006

B.Eng. in Geoinformatics Engineering
College of Engineering, Guindy, Anna University, May 2000

3. Academic experience

Aug 2013 - present: Assistant Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University
Aug 2012 - Aug 2013: Assistant Professor, Department of Applied Sciences, Nicholls State University, Thibodaux, LA
Apr 2010 – Aug 2012: Postdoctoral Associate/Research Scientist, Remote Sensing Laboratory, University at Buffalo, Buffalo, NY
Apr 2009 - Mar 2010: Programmer/Analyst (Project), Remote Sensing Laboratory, University at Buffalo, Buffalo, NY

4. Non-academic experience

Feb 2002 - Aug 2004: Digital Photogrammetry Engineer (Project Lead), Geofiny Tech. Pvt. Ltd., Chennai, India
May 2001 - Feb 2002: Spatial Data Executive, DSM Soft Pvt. Ltd, Trichi, India
Jul 2000 - Feb 2001: Photogrammetry Operator, Blom UAE, Abu Dhabi, UAE

5. Certifications or professional registrations

6. Current membership in professional organizations

- American Society of Photogrammetry and Remote Sensing

7. Honors and awards

- American Society of Photogrammetry and Remote Sensing **Roger Hoffer Membership Award 2018** (Honorable Mention), presented at ASPRS Annual conference 2018, Denver, CO
- American Society of Photogrammetry and Remote Sensing **ESRI award for Best Scientific Pape**r, 3rd prize for the paper co-authored, presented at ASPRS Annual conference 2018, Denver, CO
- Florida Atlantic University's OWL Research Magazine published a story on the lab's research on using Drone Imagery for better disaster response, Spring 2018
- Nominated by students for **Exceptional Faculty Award** nominated in 2016-2017
- **Exceptional Faculty Award**, Northern Campus Achievement Award 2015-2016, Florida Atlantic University
- **ASPRS Member of the Year 2015**, FL Region of American Society of Photogrammetry and Remote Sensing (ASPRS), awarded at ASPRS FL Region Annual Meeting 2015, Naples, FL
- **INPHO AWARD 2006** for academic excellence in Stuttgart University of Applied Sciences,

Germany

8. Service activities (within and outside of the institution)

- Member, Standing Committee on Geospatial Data Acquisition Technologies, AFB80, Transportation Research Board Member (Senior Support Personnel), International Society of Photogrammetry and Remote Sensing, WG I/7: Mobile Mapping Technology
- Early Adopter, NASA's ICESat-2 program, Incorporation of simulated ICESat-2 (MABEL) data to increase the time series and accuracy of Greenland/Antarctica Ice Sheet DDEM
- Advisor, Florida Atlantic University's American Society of Photogrammetry and Remote Sensing (ASPRS) Student Chapter
- Advisor, Florida Atlantic University's Florida Surveying and Mapping Society (FSMS) Student Chapter
- Member, Department Resource committee and College Research committee member (2017-present)
- Member, Department and College UG committee member (2013-2017)

9. Selected publications

- **Nagarajan, S.**, S. Khamaru & P. De Witt (2019): UAS based 3D shoreline change detection of Jupiter Inlet Lighthouse ONA after Hurricane Irma, International Journal of Remote Sensing, DOI: 10.1080/01431161.2019.1569792
- **Nagarajan, S.**, and S. Moafipoor, Boresight Calibration of Low Point Density LIDAR sensors, Photogrammetric Engineering and Remote Sensing Journal, Vol. 84. No. 10, October 2018, pp. 619-627
- **Nagarajan, S.**, T. Schenk, Feature-based registration of historical aerial images by Area Minimization, ISPRS Journal of Photogrammetry and Remote Sensing, Volume 116, June 2016, Pages 15-23

1. Name

Barry T. Rosson, Ph.D., P.E., F.ASCE
Professor, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Doctor of Philosophy – Civil (Structural) Engineering
Auburn University, Auburn, Alabama, 1991

Master of Science – Civil (Structural) Engineering
Texas A&M University, College Station, Texas, May 1985

Bachelor of Science (Magna Cum Laude) – Civil Engineering
Texas A&M University, College Station, Texas, May 1983

3. Academic experience

July 2007 – Present	Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University, Boca Raton, Florida:
April 2011 – January 2014	Vice President for Research, FAU
October 2010 – April 2011	Interim Vice President for Research, FAU
July 2007 – January 2014	Dean, Graduate College, FAU
July 2004 – June 2007	Associate Dean, Office of Research and Graduate Studies, University of Nebraska, Lincoln, Nebraska
August 2003 – June 2007	Professor, Department of Civil Engineering, UNL
August 2003 – June 2004	Associate Chair, Department of Civil Engineering, UNL
January 2003 – June 2004	Director of Graduate Studies, College of Engineering, UNL
August 1997 – July 2003	Associate Professor, Department of Civil Engineering, UNL
July 1991 – July 1997	Assistant Professor, Department of Civil Engineering, UNL

4. Non-academic experience

January 1985 – August 1987: Structural Engineer, Ellisor and Tanner, Inc., Dallas, Texas

5. Certifications or professional registrations

- Registered Professional Engineer, State of Nebraska, E-7866

6. Current membership in professional organizations

- Fellow of the American Society of Civil Engineers
- Fellow of the Architectural Engineering Institute
- Member of the Structural Stability Research Council
- Member of the American Society for Engineering Education

7. Honors and awards

- Chapter Honor Member, Chi Epsilon, University of Nebraska, November 2004
- Holling Family Master Teacher Award, College of Engineering, April 2003, 2002, 1995
- Distinguished Teaching Award, University of Nebraska Honors Convocation, April 2003
- Recognition for Contributions to Students, University of Nebraska, 2003, 2002, 2001, 1995
- Faculty Service Award, College of Engineering, University of Nebraska, April 2004, 2000
- Outstanding Advisor Recognition, College of Engineering, University of Nebraska, Feb. 2004

- Best Paper Award, TRB Committee on Roadside Safety Features, January 1993
- Phi Kappa Phi, Tau Beta Pi, Chi Epsilon, Phi Eta Sigma

8. Service activities (within and outside of the institution)

- National Leadership and Service:
- Chair of the Committee on Professional Practice (ASCE Presidential and Board Appointment)
- Chair of the Council of Institute Presidents (ASCE)
- President of the Architectural Engineering Institute (ASCE/AEI)
- Associate Editor of the Journal of Structural Engineering (ASCE/SEI)
- Institutional Service:
- Chair of the Departmental Personnel Committee (FAU)
- Member of the College Personnel Committee (FAU)
- Coordinator of the Unified Ph.D. Engineering Program (UNL)
- Chair of the University Academic Planning Committee (UNL)

9. Selected publications

- Keierleber, C.W., **Rosson, B.T.**, "Higher-Order Implicit Dynamic Time Integration Method," ASCE Journal of Structural Engineering, Vol. 131, No. 8, pp. 1267-1276, 2005.
- **Rosson, B.T.**, Suelter, J.L., "Closed-Form Equations for Hardening of Sand-Lime Mortar Joints," ASCE Journal of Engineering Mechanics, Vol. 27, No. 6, pp. 574-581, 2001.
- Boothby, T.E., **Rosson, B.T.**, "Elasto-Plastic Hardening and Shakedown of Masonry Arch Joints," Meccanica, Vol. 34, pp. 71-84, 1999.
- **Rosson, B.T.**, Soyland, K., Boothby, T.E., "Inelastic Behavior of Sand-Lime Mortar Joint Masonry Arches," Engineering Structures, Vol. 20, Nos. 1-2, pp. 14-24, 1998.
- **Rosson, B.T.**, Rohde, J.R., Klovsky, R., "Behavior and Design of Static-Cast Prestressed Concrete Distribution Poles," PCI JOURNAL, Vol. 41. No. 5, pp. 94-106, Sep.-Oct., 1996.
- **Rosson, B.T.**, Faller, R.K., Ritter, M.A., "Performance Level 2 and Test Level 4 Bridge Railings for Timber Decks," Transportation Research Record 1500, Journal of the Transportation Research Board, National Research Council, Washington, D.C., pp. 102-111, 1995.
- **Rosson, B.T.**, Tedesco, J.W., "Dynamic Response of Dolos Armor Units to Pendulum Impact Loads," Computers and Structures, Vol. 47, No. 4/5, pp. 641-652, 1993.
- **Rosson, B.T.**, "Modeling the Influence of Residual Stress on the Ultimate Load Conditions of Steel Frames," North American Steel Construction Conference, SSRC, Baltimore, April 2018.
- **Rosson, B.T.**, "Modeling the Stiffness Reduction Conditions of Steel Beam-Columns," EuroSteel 2017, Copenhagen, Denmark, September 2017.
- **Rosson, B.T.**, Keierleber, C.W., "Higher-Order MDOF Time Integration Methods," Second M.I.T. Conference on Computational Fluid and Solid Mechanics, Cambridge, June 2003.
- **Rosson, B.T.**, Boothby, T.E., "Hardening and Shakedown of Masonry Arch Joints," Second International Arch Bridge Conference, Venice, Italy, October 1998.
- Boothby, T.E., **Rosson, B.T.**, "Plastic Shakedown of Masonry Arch Structures," Twelfth U.S. National Congress of Applied Mechanics, Seattle, June 1994.
- Textbook: **Rosson, B.T.**, "Introduction to Nonlinear Behavior of Structures," ISBN 978-1-5249-5590-8, Kendall Hunt Publishing Company, 2018.

10. Professional development activities

- Instructor, Continuing Education Course for Professional Engineers, "Nonlinear Structural Analysis Methods Used in Modern Steel Design", NASCC Conference, St. Louis, April 2019.

1. Name

Panagiotis D. Scarlatos, Dr.-Eng.
Professor, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Dr.-Eng. - Doctorate Degree in Civil Engineering
Aristotle University of Thessaloniki, Greece, 1981

Dipl.-Eng. - Diploma in Civil Engineering (5-year)
Aristotle University of Thessaloniki, Greece, 1972

3. Academic experience

2013 – present	Professor, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
2009 – 2013	Chair & Professor, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
2006 – 2010	Executive Director, University Consortium for Intermodal Transportation Safety and Security (UCITSS)
2006 – 2016	Director, Center for Intermodal Transportation Safety and Security, FAU
2005 – 2009	Chair & Professor, Department of Civil Engineering, College of Engineering and Computer Science, FAU
2004 - 2005	Interim Chair & Professor, Department of Civil Engineering, College of Engineering and Computer Science, FAU
2001 – 2004	Professor of Civil & Ocean Engineering, Department of Civil Engineering, College of Engineering and Computer Science, FAU
1996 – 2001	Professor & Coordinator of Civil Engineering Graduate Program, Department of Ocean Engineering, College of Engineering and Computer Science, FAU
1989 – 1996	Associate Professor & Coordinator of Water Resources Graduate Program, Department of Ocean Engineering, College of Engineering and Computer Science, FAU
1981 – 1985	Post-Doctoral Research Associate, Coastal Ecology Laboratory & Louisiana Water Resources Research Institute, Louisiana State University
1975 – 1981	Lecturer/Assistant Engineer, Hydraulics & Hydraulic Structures Laboratory, Aristotle University of Thessaloniki, Greece

4. Non-academic experience

1985 – 1989 Staff Water Resources Engineer/Water Resource Engineer, Division of Water Resources, Department of Resource Planning, South Florida Water Management District, WPB, FL
1990 – 2012 Consultant/Expert Witness in local, national and international cases.

5. Certifications or professional registrations

- Professional Civil Engineer, License. # 1298, Greece – EU (1972)
- Certification, Military Engineer, Greek Army (1972)

6. Current membership in professional organizations N/A

7. Honors and awards

- Nominated for the Albert Nelson Who is Who Marquis Lifetime Achievement Award (2019)
- Dean's Faculty Award, College of Engineering, FAU (2003)
- Teaching Incentive Program (TIP) Award, College of Engineering, FAU (1995)

- FEEDS Exceptional Professor Award, FAU (1994)
- Fulbright Scholar Research Grantee (1992)
- Outstanding Achievement and Performance Award, Florida Atlantic University (1990)
- NATO Research Fellow (1978-79)
- Merit Scholarship, Institute of National Scholarships, Greece (1967-68-69)

8. Service activities (within and outside of the institution)

- FAU Personnel Committee (2013 – today)
- FAU Faculty Credentialing Team (2012 – today)
- External Reviewer of Faculty Promotions, Greek Public Universities System (APELLA), Appointed by the Greek Ministry of Education, Greece, (2012 – today)
- PBC Pollution Prevention Coalition, FAU representative (2008 – today)

9. Selected publications

- Koutitas, C.G. and **Scarlatos, P.D.** Computational Modelling in Hydraulics and Coastal Engineering, Taylor & Francis Group, CRC Press, 2016.
- Soltani-Sobh, A., Heaslip, K., **Scarlatos, P.** and Kaisar, E., 2016. "Reliability based pre-positioning of recovery centers for resilient transportation infrastructure", Int'l Journal of Disaster Risk Reduction, Elsevier, 19:324-333.
- Kaisar, E., Parr, S. and **Scarlatos,** P.D., 2010. "*An Urban Chemical Disaster Traffic Simulation Model: A Case Study for No-Notice Emergency Evacuation Development*", Latest Trends on Urban Planning and Transportation, Manoj Jha (ed): 33-47.
- **Scarlatos, P.D.,** Kaisar, E. and Teegavarapu, R., 2009. "*Modeling and Simulation of Catastrophic Events Affecting Critical Infrastructure Systems*", 11th Int'l Conf. on Mathematical Methods and Computational Techniques in Electrical Engineering, Vouliagmeni, Greece: 324-346.
- **Scarlatos, P.D.,** Chapter 9. "*Estuarine Hydrodynamics*", and Chapter 10. "*Ecohydrodynamics*", in: Environmental Hydraulics, 1996, V.P. Singh and W. Hager (eds.), Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 289-348.
- **Scarlatos, P.D.,** 2007. "*Flow Measurements in Submerged Tidal Spillways*", 13th Int'l Conference on Computational Methods and Experimental Measurements, Prague, Czech Republic.

1. **Name: Khaled Sobhan**

2. **Education:**

- **Northwestern University, Illinois: Ph.D. in Civil Engineering, 1997**
  Area: Geotechnical Engineering, Sustainable Infrastructure Materials
- **The Johns Hopkins University, Maryland: M.S. in Civil Engineering, 1991**
  Area: Soil Mechanics, Constitutive Behavior, Geotechnical Engineering
- **Bangladesh University of Engineering & Technology: B.S. in Civil Engineering, 1988**
  Concentration: Structural Engineering

3. **Academic experience**

2018 - present	Interim Dean of Graduate College, Florida Atlantic University
2013 - present	Professor of Civil Engineering, Florida Atlantic University
2007 - 2012	Associate Professor (tenured), Civil Engineering, Florida Atlantic University
2003 - 2007	Assistant Professor, Civil Engineering, Florida Atlantic University
1999 - 2002	Assistant Professor, Civil Engineering., New Mexico State University
1995 - 1999	Visiting Assistant Professor, Civil Engineering, Bucknell University

4. **Non-academic experience:**
   Consultant for **The World Bank** project titled "Benchmarking of the Central Soils and Materials Research Station (CSMRS)," New Delhi, India; Agricultural and Rural Development Division, **The World Bank**, International Bank for Reconstruction/Development, Washington, D.C. (2012 – 2013)

5. **Certifications or professional registrations**: EI

6. **Current membership in professional organizations**: ASCE, DFI, Geo-Institute

7. **Honors and awards**
   2016/2017 Award for Excellence and Innovation in Undergraduate Teaching, Florida Atlantic University, April, 20016.
   2009 Excellence in Graduate Mentoring Award, Graduate College, Florida Atlantic University.
   2006/2007 *Award for Excellence and Innovation in Undergraduate Teaching*, Florida Atlantic University, April, 2007.
   Recipient of **2018 McGuffey Longevity Award**, Textbook & Academic Authors Association (TAA), during the 31st Annual TAA Conference, June 15, 2018, Santa Fe, New Mexico.

8. **Service activities** (within and outside of the institution)
   - Interim Dean of Graduate College(April 2018 – present), Florida Atlantic University
   - University Tenure/Promotion Committee (2016-present); nine-member committee
   - Sustained Performance Evaluation (SPE) Committee, Provost's office (2013-2016). Development of the SPE governance document (post-tenure). (http://www.fau.edu/ufsgov/Files/2016_2017/SPE-Memo-October-3-2016.pdf)
   - Provost Task Force for Celebrating Faculty Success (2011-2012)
   - University Prog. Review Committee, Office of Vice President for Strategic Planning (2012)
   - University Faculty Senate (2009-2012)
   - University Graduate Council (2005-2010). Development of the Graduate Governance Document (http://www.fau.edu/graduate/docs/Graduate_College_Governance_Document.pdf)
   - Chair, College Personnel Committee (tenure/promotion), Engr. & Comp. Sci. (2016-2018)
   - Faculty President, College of Engineering & Computer Science (2010-2013)
   - Chair, College Graduate Studies Committee, Engr. & Comp. Sci. (2005-2010)

- Past Chair, 25-member TRB National technical committee AFS90: *Chemical and Mechanical Stabilization*, *Transportation Research Board*, 2005-2011).
- Member, TRB technical committee AFS70: *Geosynthetics*, *Transportation Research Board*, National Research Council, Washington, D.C., (2012-present).

9. Selected publications

Principles of Geotechnical Engineering, 9th Edition
Braja M. Das and Khaled Sobhan
Cengage Learning, 2018; **ISBN-13:** 978-1305970939

Principles of Geotechnical Engineering, 8th Edition
Braja M. Das and Khaled Sobhan
Cengage Learning, 2014; **ISBN-13:** 978-1133108665

Principles of Geotechnical Engineering, SI Version, 8th Edition
Braja M. Das and Khaled Sobhan
Cengage Learning, 2014; **ISBN-13:** 978-1133108672

1. **Slope Stability**, Book Chapter in ***Geotechnical Engineering Handbook***, Braja M. Das, Editor in Chief, ISBN: 978-1-932159-83-7, J. Ross Publishing, August 2010, 75 p.
2. Sethy, B. P., Patra, C. R., Das, B. M., and Sobhan, K. (2018). "Bearing Capacity of Circular Foundation on Sand Layer of Limited Thickness Underlain by Rigid Rough Base Subjected to Eccentrically Inclined Load," ASTM Geotechnical Testing Journal, May 2019 -- GTJ Volume 42, Issue 3, GTJ20170420
3. Sobhan, K. (2017). "Challenges due to Problematic Soils: A Case Study at the Crossroads of Geotechnology and Sustainable Pavement Solutions." *Innovative Infrastructure Solutions*, 2:40, December 2017, Springer International Publishing, DOI 10.1007/s41062-017-0070-y.
4. Sobhan, K., Gonzalez, L., and Reddy, D. V. (2016). "Durability of a Pavement Foundation made from Recycled Aggregate Concrete Subjected to Cyclic Wet-dry Exposure and Fatigue Loading," *Materials and Structures*, RILEM, Volume 49, Issue 6, pp. 2271-2284, June 2016.
5. Reddy, D. V., Sobhan, K., Liu, L., and Young, J. D. (2015). "Size Effect on Fire Resistance of Structural Concrete," *Engineering Structures*, Volume 99, pp. 468-478.
6. Reddy, D. V., Sobhan, K., and Young, J. D. (2015). "Fire Resistance of Structural Concrete Retrofitted with Carbon Fiber Reinforced Polymer Composite," *Transportation Research Record*, Journal of the Transportation Research Board, Washington, D.C., Volume 2522, pp. 151-160.
7. Reddy, D. V., Edouard, J-B., and Sobhan, K. (2013). "Durability of Fly-ash-based Geopolymer Structural Concrete in the Marine Environment," *ASCE Journal of Materials in Civil Engineering*, Volume 25, Issue 6, pp. 781–787.
8. Sobhan, K., Ramirez, J. C., and Reddy, D. V. (2012). "Cement Stabilization of Highly Organic Subgrade Soils for Controlling Secondary Compression Settlement," *Transportation Research Record*, *Journal of the Transportation Research Board*, Volume 2310, pp. 103-112.
9. Ali, H., and Sobhan, K. (2012). "On the Road to Sustainability: Properties of Recycled Superpave Mixes," *Transportation Research Record: Journal of the Transportation Research Board, The National Academies,* Volume 2292, pp. 88-93.
10. Sobhan, K., George, K. P., Pohly, D. and Ali, H. (2010). "Stiffness Characterization of Reinforced Asphalt Pavement Structures Built Over Soft Organic Soils," *Transportation Research Record: Journal of the Transportation Research Board, The National Academies,* Volume 2186, pp. 67-77.

10. **Professional development activities:** Numerous workshops, training programs, conferences.

1. Name

Aleksandar Stevanovic, PhD, PE
Assoc. Prof. of Civil, Environmental & Geomatics Engineering, Florida Atlantic University
Director, Lab for Adaptive Traffic Operations & Management

2. Education

Ph.D., Civil and Environmental Engineering
University of Utah, Salt Lake City, December 2005

M.Sc., Civil and Environmental Engineering
University of Utah, Salt Lake City, August 2003

B.Sc., Faculty of Transport and Traffic Engineering
University of Belgrade, Serbia, May 1998

3. Academic experience

06/2015-present:	Program Leader – Infrastructure Systems, Institute for Sensing and Embedded Network Systems Engineering, Florida Atlantic University, Boca Raton, FL.
04/2015-present:	Associate Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University, Boca Raton, FL.
07/2009-present:	Director, Laboratory for Adaptive Traffic Operations and Management (LATOM), Florida Atlantic University, Boca Raton, FL.
07/2009-04/2015:	Assistant Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University, Boca Raton, FL.
01/2006-06/2009:	Research Assistant Professor, Department of Civil and Environmental Engineering, University of Utah, Salt Lake City, UT.

4. Non-academic experience

Flight Operations Engineer, Yugoslav Airlines, Belgrade, Serbia. 06/1998-02/2000.

5. Certifications or professional registrations

P.E. License with the State of Utah (License #: 7124750-2202).

6. Current membership in professional organizations

- Institute of Transportation Engineers (ITE)
- American Society of Civil Engineers (ASCE)

7. Honors and awards

- Outstanding Engineering Achievement Merit Award, awarded by the Engineers' Council Honors & Awards Committee, 2019.
- Fulbright Specialist – selected for the Fulbright Specialist Roster for a tenure of three years between June 8, 2018 and June 8, 2021.
- Honorary Visiting Faculty, Indian Institute of Technology Madras, Department of Civil Engineering, Nov-Dec, 2018.
- Nominated for FAU Researcher of the Year 2013, 2014, and 2015 Award, in category of Assistant Professors, by College of Engineering and Computer Science (only one nomination per category in each college).

8. Service activities (within and outside of the institution)

- FAU representative with the Transportation Research Board, The National Academy of Science.
- Committee of Traffic Signal Systems - AHB25, Transportation Research Board.
- Editorial Board of "Road and Traffic" - Serbian journal for road transportation.
- Editorial Board of "Journal PROMET-Traffic & Transportation" – Croatian journal for road transport.
- AHB25 Committee's liaison with ASCE Committee on Advanced Technology in Transportation.
- Eminent Engineer, Tau Beta Pi Florida Epsilon (inducted in fall 2012).

9. Selected publications

- Chowdhury, S-E-S., **Stevanovic, A.**, and Mitrovic, N. (2018) "Evaluation of Multiple Hardware and Software in the Loop Signal Controllers in Simulation Environment." Transportation Research Record – Journal of The Transportation Research Board, Article first published online: July 1, 2018. https://doi.org/10.1177/0361198118784168
- Parmar, R.S., Trivedi, B. and **Stevanovic, A.** (2018) A Model with Traffic Routers, Dynamically Managing Signal Phases to Address Traffic Congestion in Real Time. Journal of Transportation Technologies, 8, 75-90.
- Dakic, I. and **Stevanovic, A.Z.** "On development of arterial fundamental diagrams based on surrogate density measures from adaptive traffic control systems utilizing stop-line detection." Transportation Research Part C, Vol. 94 (2018) 133-150.
- Biswas, D., Su, H., Wang, C., Blankenship, J., and **Stevanovic, A.** (2017). "An Automatic Car Counting System using OverFeat Framework." Sensors 2017, 17, 1535.
- Soltani-Sobh, A., **Stevanovic, A.Z.**, Ostojic, M., Ma, J., and Hale, D. "Development of Congestion Causal Pie Charts for Arterial Roadways." International Journal for Traffic and Transportation Engineering, 2017, 7(1): 117 - 133.
- Ostojic, M., **Stevanovic, A.Z.**, Jolovic, D., and Mahmassani, H.S. "Assessment of Signal Timing Plan Robustness in an Arterial Corridor through Seasonal Variation of Traffic Flows." Transportation Research Record: Journal of the Transportation Research Board, No. 2619, 2017, pp. 85–94.

10. Professional development activities

- Identification and Application of Implementable Research Outcomes from FAU TSM&O Projects, Florida Department of Transportation ($99,923); February 2019 – July 2020. (PI)
- Benefits of Adaptive Traffic Control Deployments - A Review of Evaluation Studies – National Cooperative Highway Research Program ($99,912); May 2018 – June 2019. (PI)
- Multiresolution Analysis of the Impacts of Complete Streets on Efficiency, Safety and Environment of Urban Corridors, Florida DOT ($299,631); May 2018 – April 2020. (PI)
- Impact of Accurate Assessment of Freeway Traffic Conditions on the Operations of I-95 Express Lanes in Broward County, Florida Department of Transportation ($99,859); November 2017 – October 2018. (PI)
- Development of a Traffic Map Evaluation Tool for TMC Applications, Florida Department of Transportation ($243,706); March 2017 – January 2019. (PI)
- Analysis of Traffic Demand Patterns and Signal Retiming Strategies for ITS-data-rich Arterials, Florida Department of Transportation ($99,725); Dec 2016 – May 2018. (PI)

1. Name

Hongbo Su, Ph.D.
Assistant Professor, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D. in Civil and Environmental Engineering, Hydrology Emphasis
Princeton University, Princeton, NJ, 2008

Ph.D. in Cartography and GIS, Remote Sensing Emphasis
Chinese Academy of Sciences, Beijing, China, 2002

Bachelor of Science in Engineering, Major in Photogrammetry and Remote Sensing
Wuhan Technical University of Surveying and Mapping, Wuhan, China, 1997

3. Academic experience

2014-present	Assistant Professor, Department of Civil, Environmental and Geomatics Engineering, College of Engineering and Computer Science, FAU
2010 – 2014	Assistant Professor, Department of Environmental Engineering, College of Engineering, Texas A&M University-Kingsville
2006-2010	Postdoctoral Research Scientist, Center for Research on Environment and Water (CREW), Institute of Global Environment & Society (IGES), Calverton, Maryland

4. Non-academic experience

5. Certifications or professional registrations

6. Current membership in professional organizations

- American Geophysical Union, member since 2004
- IEEE, senior member since 2007

7. Honors and awards

- 2017 Outstanding Faculty Award for Northern Campus of FAU
- Certificate of Appreciation from the NASA Earth Science Technology Office in 2014 to recognize the valuable contribution and outstanding support to the Advanced Information Systems Technology Program

8. Service activities (within and outside of the institution)

Services to FAU

- Departmental Undergraduate Committee of CEGE (2016-2018)
- College Undergraduate Committee (2016-2018)
- College Textbook Affordability Committee (2016-2018)
- College Engineering Math Committee (2016-2018)
- FAU Libraries Collection Advisory Committee (2018-present)

Services to Discipline and Profession

- Editorial Board for Journal of Geoinformation Science, 2016-present
- Guest Editor for *Advances of Meteorology* in 2016
- Guest Editor for *Physics and Chemistry of the Earth* in 2016, 2017 and 2018

- IEEE Technical Committee for Environmental Sensing, Networking and Decision-Making (ESND)
- IEEE Earth Science Informatics Technical Committee
- Technical Program Committee (TPC) on *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)* in 2016
- Session Convener for AUG 2016 Fall Meeting
- Session Convener for AUG 2015 Fall Meeting
- Panel Reviewer for NASA *Advanced Information Systems Technology* (AIST) *program* 2008, 2011, 2013
- Organizing Committee on *the 4th International Workshop on Catchment-scale Hydrological Modeling and Data Assimilation* in 2010
- Organizing Committee on *the 12th Chinese-American Kavli Frontiers of Science* in 2009
- Panel Reviewer for *National Natural Science Foundation of China* from 2007 - 2012
- Technical Program Committee (TPC) on *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)* in 2006
- Reviewer for *IEEE Transactions on Geoscience and Remote Sensing*, *Journal of Geophysical Research* (JGR), *Journal of Hydrology*, *Photogrammetric Engineering and Remote Sensing*, *Journal of Arid Environments*, *Science of China*

9. Selected publications

- Liu, Kai, Hongbo Su, Jing Tian, Xueke Li, Weimin Wang, Lijun Yang, and Hong Liang. "Assessing a scheme of spatial-temporal thermal remote-sensing sharpening for estimating regional evapotranspiration." *International Journal of Remote Sensing* 39, no. 10 (2018): 3111-3137.
- Liu, Kai, Hongbo Su, Xueke Li, Shaohui Chen, Renhua Zhang, Weimin Wang, Lijun Yang, Hong Liang, and Yongmin Yang. "A Thermal Disaggregation Model Based on Trapezoid Interpolation." *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* (2018).
- Hongbo Su, Sudhagar Nagarajan, Jinwei Dong, (2017) Physical and Economic Processes of Ecosystem Services Flows, *Physics and Chemistry of the Earth, Parts A/B/C,* Vol. 101, 1-2
- Biswas, D., Su, H., Wang, C., Blankenship, J., & Stevanovic, A. (2017). An automatic car counting system using OverFeat Framework. *Sensors*, *17*(7), 1535.
- Khadim, F. K., Su, H., & Xu, L. (2017). A Spatially weighted optimization model (SWOM) for Salinity mapping in Florida Bay using Landsat images and in-situ observations. *Physics and Chemistry of the Earth, Parts A/B/C*, Vol. 101, 86-101
- Liu, K., Su, H., & Li, X. (2017). Comparative Assessment of Two Vegetation Fractional Cover Estimating Methods and Their Impacts on Modeling Urban Latent Heat Flux Using Landsat Imagery. *Remote Sensing*, *9*(5), 455.

10. Professional development activities

Writing and Designing NIH Workshop by Grant Training Center held in University of Miami in 2017

1. Name

Ramesh S. V. Teegavarapu, Ph.D., P.E.
Professor & Graduate Program Director, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University
Director, Hydrosystems Research Laboratory (HRL: hrl.fau.edu)

2. Education

Ph.D. in Civil Engineering, Water Resources Engineering Emphasis
University of Miami, Coral Gables, FL, 2000

Master of Science in Civil Engineering, Water Resources Engineering Emphasis
Indian Institute of Science, Bangalore, India, 1995

Bachelor of Engineering in Civil Engineering
Osmania University, India, May 1992

3. Academic experience

May 2018-present	Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University
May 2018- present	Graduate Program Chair, May 2018- Present, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University
June-August, 2016	Visiting Research Professor, Politecnico Di Torino, University of Brescia, Italy.
Nov-Jan, 2016	Visiting Research Professor, Research Center for Urban Safety and Security Kobe University Kobe, Japan
2012-2018	Associate Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University
2006-2012	Assistant Professor, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University
2004-2006	Assistant Director, Kentucky Water Resources Research Institute (KWRRI), University of Kentucky, Lexington, USA, 40506
2004-2006	Adjunct Faculty, Department of Civil Engineering, University of Kentucky, Lexington, USA, 40506-0281
2001-2004	Assistant Professor (Visiting), Department of Civil Engineering, University of Kentucky, Lexington, USA, 40506-0281

4. Non-academic experience

5. Certifications or professional registrations

Professional Engineer. *State of Kentucky Board of Professional Engineers.*
License #: 23112 (6/11/2003)

6. Current membership in professional organizations

- Environmental and Water Resources Institute (EWRI)
- International Association for Hydro-Environment Engineering and Research (IAHR)
- International Society for Environmental Informatics (ISEI)

7. Honors and awards

- Fulbright Scholar Award, 2016-2017. Awarded by United States Department of State Bureau of Educational and Cultural Affairs.
- Research Scholar of the Year, Florida Atlantic University, University Level award, 2017.

- Excellence and Innovation in Undergraduate Teaching Award, University Level award, FAU, 2018, Florida Atlantic University.
- College of Engineering and Computer Science (COECS) Senior Faculty Teaching Award, FAU, 2019. One award for tenured faculty for the entire college.
- Member, OPACHE (Open Panel of Commission for Hydrology Experts), WMO – (Hydrology and Data Operations and Management, Water Resources Assessment, Hydrological Forecasting and Prediction), 2016.
- Outstanding Service Award as a Member of the Organizing and Steering Committee of Weather Radar and Hydrology (WRaH), 2014, EWRI, ASCE.
- Faculty Research Mentoring Award, FAU, 2014.

8. Service activities (within and outside of the institution)

- Member, Graduate Program Committee, College of Engineering g and Computer Science, FAU
- Associate Editor, Journal of Hydrologic Engineering, ASCE, Guest Editor, JHE, ASCE, Editorial board member, Journal of Hydro-informatics.
- Reviewer for over 75 international technical journals and 34 international conferences.
- Chaired, convened and moderated over 58 technical sessions at national and international conferences and served on advisory committees of conferences and as general and technical co-chair of two international conferences.
- Leadership Team Member, International Association for Hydro-Environment Research (IAHR) Water Resources Management Committee, 2010-till date.
- Member, Hydro-Climate Technical Committee, EWRI, American Society of Civil Engineers, 2014-till date.
- Member, Climate Change Working (CWG) Group, IAHR 2014 – till date.
- Member, Panta Rhei Working Group on Modeling Hydrological Processes and Changes, IAHS. 2014-2016.

9. Selected publications

45 refereed journal papers, 6 under review; 64 refereed conference papers; 31 refereed extended abstracts; 20 book chapters, 5 book articles; 1 book (sole author); 4 edited books; 47 Research Posters; Over 1400 citations, H-index:18 and i10: 30

- Ramesh S. V. Teegavarapu, Exploring Geometric Patterns in Streamflow Time Series: Utility for Forecasting? 2018, Hydrology Review (: DOI: 10.21666/nh2018.127), 2018
- Ramesh S. V. Teegavarapu, Aneesh Goly. 2018. Optimal Selection of Predictor Variables in Statistical Downscaling Models of Precipitation, Water Resources Management, 32(6), 1969-1992.
- Ramesh S. V. Teegavarapu and Singaiah Chintalapudi, Incorporating Influences of Shallow Groundwater Conditions in Curve Number-based Runoff Estimation Methods, Water Resoruces Management, 2018. https://doi.org/10.1007/s11269-018-2053-y
- **Ramesh S. V. Teegavarapu**, Ala Aly, Chandra S. Pathak, Jon Ahlquist, Henry Fuelberg, J Hood, Infilling Missing Precipitation Records using Variants of Spatial Interpolation and Data-Driven Methods: Use of Optimal Weighting Parameters and Nearest Neighbor-based Corrections, 2017. International Journal of Climatology. DOI: 10.1002/joc.5209. 38(2), 776-793.
- **Ramesh S. V. Teegavarapu** and Anurag Nayak. Evaluation of Long-term Trends in Extreme Precipitation: Implications of Infilled Historical Data and Temporal-Window based Analysis, Journal of Hydrology, 2017. 550, 614-634.

1. Name

James H. VanZwieten Jr., Ph.D.
Assistant Research Professor, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D. Ocean Engineering
Florida Atlantic University, Boca Raton, FL, 2003-2007

M.S. Ocean Engineering
Florida Atlantic University, Boca Raton, FL, 2001-2003

B.S. Ocean Engineering
Florida Atlantic University, Boca Raton, FL, 1996-2001

3. Academic experience

Jan 2019- Present	Assistant Research Professor, Department of Civil, Environmental & Geomatics Engineering, College of Engineering and Computer Science, FAU
July 2010- Dec. 2018	Assistant Research Professor, Southeast National Marine Renewable Energy Center, FAU
Dec. 2007-July 2010	Visiting Faculty / Ocean Engineer, Center for Ocean Energy Technology, College of Engineering and Computer Science, FAU
May 2007- Dec. 2007	Visiting Faculty / Ocean Engineer, Department of Ocean Engineering, College of Engineering and Computer Science, FAU

4. Non-academic experience

5. Certifications or professional registrations

6. Current membership in professional organizations

7. Honors and awards

- Received the Journal of Ships and Offshore Structure's award for the best paper of 2008
- Awarded 2nd place in the Student Poster Competition at the 2002 MTS/IEEE Oceans Conference

8. Service activities

I. Community Service (selected):
- Judge for the 2012 and 2013 FAU Graduate Student Poster Completions
- Judge for the 2014 and 2015 DTD Undergraduate Student Presentation and Poster Competitions

II. Committees (selected):
- Florida Keys Community College, Engineering Technician, Advisory Committee
- FAU Distinction through Discovery, Co-Curricular Committee
- Marine Energy Conversion, US Department of Energy, Advanced Water Power Program, Resource Assessment Subcommittee
- Chair In-Stream Hydrokinetic sub-committee in ASCE COPRI Marine Renewable Energy committee

III. Student Teaching and Mentoring (selected)

- Principle Investigator for NSF Research Experiences for Undergraduates (REU) Site in Ocean Current based Electricity Production, 2017-2019.
- Summer Undergraduate Research Fellowship (SURF) student advisor, (2015, 2016, 2017, 2018, 2019)
- Learning Environment and Academic Research Network (LEARN) undergraduate student advisor, 2017
- Undergraduate research advisor for seventeen past and five current students

IV. Journal Referee

- IEEE Transactions on Sustainable Energy; IEEE Transactions on Mechatronics; IEEE Oceanic Engineering; Renewable Energy; Journal of Atmospheric and Oceanic Technology; International Journal of Marine Energy; Ocean Engineering; Energy; Marine Technology Society Journal; Journal of Hydraulic Research; Ships and Offshore Structures; FAU Undergrad Research Journal

V. Conference Referee

- Energy and Water Conference; American Society of Mechanical Engineering, OMAE conference; Global Marine Renewable Energy Conference, Marine Energy Technical Symposium; International Marine Renewable Energy Conference, Marine Energy Technical Symposium; European Wave and Tidal Energy Conference

VI. Grant Reviewer

- NSF (3 panels & 2 ad hoc); US Department of Commerce/NOAA Sea Grant SBIR (Phase I & Phase II); DOE SBIR solicitation (2 x Phase I); FAU Curriculum Grants Program (twice); OURI Research Grant Competition (15 total reviews)

9. Publications (selected)

- P. Pyakurel, **J.H. VanZwieten**, M. Dhanak, N. Xiros (2017) "Numerical modeling of turbulence and its effect on ocean current turbines" *International Journal of Marine Energy*, 17:84-97.
- P. Pyakurel, **J.H. VanZwieten**, C. Sultan, M.R. Dhanak, N.I Xiros (2017) "Numerical Simulation and Dynamical Response of a Moored Hydrokinetic Turbine Operating in the Wake of an Upstream Turbine for Control Design" *Renewable Energy*, 114 (Part B), 1134-1145.
- P. Pyakurel, **J.H. VanZwieten**, W. Tian, P. Ananthakrishnan (2017) "Analytic characterization of the wake behind in-stream hydrokinetic turbines" *Marine Technology Society Journal*, 51 (6), 58-71.
- **J.H. VanZwieten**, L.T. Rauchenstein, L. Lee (2017) "An Assessment of Florida's Ocean Thermal Energy Conversion (OTEC) Resource" *Renewable and Sustainable Energy Reviews*, 75, 683-691.
- **J.H. VanZwieten**, P. Pyakurel, T. Ngo, C. Sultan, N.I. Xiros (2016) "An assessment of using variable blade pitch for moored ocean current turbine flight control" *International Journal of Marine Energy*, 13, 16-26.
- **J. VanZwieten**, W. McAnally, J. Ahmad, T. Davis, J. Martin, M. Bevelhimer, A. Cribbs, R. Lippert, T. Hudon, M. Trudeau (2014) "In-Stream Hydrokinetic Power – A Review and Appraisal" *ASCE Journal of Energy Engineering*, 141 (3), 04014024(1-16).
- **J.H. VanZwieten**, N. Vanrietvelde, and B. Hacker. (2013) "Numerical simulation of an experimental ocean current turbine" *IEEE Journal of Oceanic Engineering*, 38 (1), 131-143.
- **J.H. VanZwieten**, F.R. Driscoll, and T.S. VanZwieten (2010) "Development of an adaptive disturbance rejection system for the rapidly deployable stable platform - Part1: Mathematical modeling and open loop response" *Ocean Engineering*, 37 (8-9), 833-846.
- **J.H. VanZwieten**, F.R. Driscoll, and G.M. Alsenas (2008) "Response characteristics and maneuverability of a small twin screw displacement hull vessel in seas" *Journal of Ships and Offshore Structures*, 3 (1), 13-40. (SaOS best paper of 2008)
- **J. VanZwieten**, F.R. Driscoll, A. Leonessa, and G. Deane (2006) "Design of a prototype ocean current turbine - Part II: flight control system" *Ocean Engineering*, 33(11-12), 1522-1551.
- **J. VanZwieten**, F.R. Driscoll, A. Leonessa, and G. Deane (2006) "Design of a prototype ocean current turbine - Part I: mathematical modeling and dynamics simulation," *Ocean Engineering*, 33 (11-12), 1485-1521.

1. Name

Peng Yi, Ph.D.
Assistant Professor, Department of Civil, Environmental & Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D., Environmental Process Engineering
Johns Hopkins University, MD, 2013

M.Eng., Municipal Engineering
Harbin Institute of Technology, China, 2008

B.Eng., Water Supply and Drainage Eng.
Harbin Institute of Technology, China 2006

3. Academic experience
2014 − present Assistant Professor, Florida Atlantic University
2013 − 2014 Postdoctoral Research Scientist, Connecticut Agricultural Experiment Station

4. Non-academic experience: Not applicable
5. Certifications or professional registrations: Not applicable

6. Current membership in professional organizations
- Member of American Chemical Society (ACS)
- Member of Association of Environmental Engineering and Science Professors (AEESP)
- Member of Sustainable Nanotechnology Organization (SNO)

7. Honors and awards
- The C. Ellen Gonter Environmental Chemistry Award 2013 for outstanding research paper, the highest award given to students by the Division of Environmental Chemistry of the American Chemical Society
- Certificate of Merit Award 2010 for outstanding first-time oral presentations presented by the Division of Environmental Chemistry of the American Chemical Society

8. Service activities (within and outside of the institution)
Service to the Institution at FAU:
Departmental Service:
- Eight graduate thesis committees
- CEGE Policy and Development Committee (2015-2017)
- CEGE Graduate Committee (2018)

College Service:
- COECS Graduate Committee (2018)
- COECS Biomedical Engineering Department Committee (2018)

Service to the Discipline/Profession:
Panelists for Funding Agencies:
- Environmental Engineering Program, Division of Chemical, Bioengineering, Environmental, and Transport System, National Science Foundation
- *Reviewers for Scholarly Journals*:
- Total of 22 manuscripts have been reviewed for the following journals
- *Symposiums Organized*:
- Nanomaterials in the Environment and Biological Systems: Physicochemical and Biological Processes Affecting Their Transformation and Transport, American Chemical Society 252nd

National Meeting, August 21-25, 2016, Philadelphia, Pennsylvania.

9. Selected publications

- Xiao, Q., Yu, S., Li, L.*, Zhang, Y., and **Yi, P.***, Degradation of bromate by Fe(II)-Ti(IV) layered double hydroxides nanoparticles under ultraviolet light, *Water Research*, 2019, 150, 310-320.
- Zhang, Y., Lu, J., **Yi, P.**, Zhang, Y., and Wang, Q., Trichloronitromethane formation from amino acids by preozonation-chlorination: The effects of ozone dosage, reaction time, pH, and nitrite, *Separation and Purification Technology*, 2019, 209, 145-151.
- Morris, C., Cupples, S., Kent, T. W., Elbassal, E. A., Wojcikiewicz E. P., **Yi, P.***, and Du, D.*, N-terminal charged residues of amyloid-β peptide modulate amyloidogenesis and interaction with lipid membrane, *Chemistry – A European Journal*, 2018, 24, 9494–9498.
- Huang, R., **Yi, P.**, and Tang, Y., Probing the interactions of organic molecules, nanomaterials, and microbes with solid surfaces using quartz crystal microbalances: methodology, advantages, and limitations, *Environmental Science: Processes & Impacts*, 2017, 19 (6), 793–811.
- Xiao, Q., Wang, T., Yu, S., **Yi, P.**, and Li, L., Influence of UV lamp, sulfur (IV) concentration, and pH on bromate degradation in UV/sulfite systems: Mechanisms and applications, *Water Research*, 2017, 111, 288–296.
- **Yi, P.**, Pignatello, J. J., Uchimiya, M., and White, J. C., Heteroaggregation of Cerium Oxide Nanoparticles and Nanoparticles of Pyrolyzed Biomass, *Environmental Science and Technology*, 2015, 49, 13294–13303.
- **Yi, P.** and Chen, K. L., Release Kinetics of Multiwalled Carbon Nanotubes Deposited on Silica Surfaces: Quartz Crystal Microbalance with Dissipation (QCM-D) Measurements and Modeling, *Environmental Science and Technology*, 2014, 48, 4406–4413.
- **Yi, P.** and Chen, K. L., Influence of Solution Chemistry on the Release of Multiwalled Carbon Nanotubes from Silica Surfaces, *Environmental Science and Technology*, 2013, 47, 12211–12218.
- Tang, L., Gu, W., **Yi, P.**, Bitter, J. L., Hong, J. Y., Fairbrother, D. H., and Chen, K. L., Bacterial Anti-Adhesive Properties of Polysulfone Membranes Modified with Polyelectrolyte Multilayers, *Journal of Membrane Science*, 2013, 446, 201–211.
- **Yi, P.** and Chen, K. L., Interaction of Multiwalled Carbon Nanotubes with Supported Lipid Bilayers and Vesicles as Model Biological Membranes, *Environmental Science and Technology*, 2013, 47, 5711–5719.
- **Yi, P.** and Chen, K. L., Influence of Surface Oxidation on the Aggregation and Deposition Kinetics of Multiwalled Carbon Nanotubes in Monovalent and Divalent Electrolytes, *Langmuir,* 2011, 27, 3588–3599.

1. Name

Yan Yong, Ph.D.
Professor & Chair, Department of Civil, Environmental and Geomatics Engineering, Florida Atlantic University

2. Education

Ph.D. in Aeronautical and Astronautical Engineering
University of Illinois at Urbana-Champaign, 1987
MS in Ph.D. in Aeronautical and Astronautical Engineering
University of Illinois at Urbana-Champaign, 1983
BS in Applied Mechanics
Wuhan University of Technology, 1982

3. Academic experience

01/2016 - present	Chair
09/2013 - 12/15	Interim Chair
09/2010 – 08/13	Associate Chair
08/2001 – present	Professor Department of Civil, Environmental and Geomatics Engineering Florida Atlantic University
08/2000 – 07/2001	Professor
08/1992 – 07/2000	Associate Professor
08/1988 - 07/1992	Assistant Professor
08/1987 - 05/1988	Visiting Assistant Professor Department of Ocean Engineering Florida Atlantic University
01/1987 - 07/1988	Postdoctoral Fellow
09/1984 - 12/1986	Research Associate Center for Applied Stochastics Research Florida Atlantic University
02/1982 - 08/1984	Research Assistant Department of Aeronautical and Astronautical Engineering University of Illinois at Urbana-Champaign

4. Non-academic experience

05/1990 - 08/1990	Visiting Scientist Wright-Patterson Air Force Base, Dayton, Ohio

5. Certifications or professional registrations

6. Current membership in professional organizations

American Society of Civil Engineering

7. Honors and awards

- Presidential Young Investigator (PYI) Award, NSF
- Outstanding Achievement and Performance Award, Florida Atlantic University, 1990.

8. Service activities (within and outside of the institution)

Director, FAU NSF STEP Program (2005-2009)

9. Selected publications

- W. Chen, Z. Hu, **Y. Yong**, and H. Su, "3-D Dynamics Virtualization Simulation System of Pool Fire Triggered by Major Hazard Installation," Journal of Software, Vol. 13, No. 9, pp.481-496, 2018
- W. Chen, **Y. Yong**, Z., Hu, H. Su, "3D Reconstruction of Simulated Vapor Cloud Explosion Triggered by Major Hazard Installation," International Journal of Modeling and Optimization, Vol. 8, No. 5, pp.266-271, 2018.
- W. Chow and **Y. Yong**, A Treatise in Fluid Dynamics, BUAA Publisher, ISBN 978-7-81124-291-1., 2012
- G. Gao, and **Y. Yong**, "A review of research on partial average based study of turbulent flows," Chinese Mechanics Abstract, Vol. 22, (2), pp. 1-20, 2008.
- G. Gao, and **Y. Yong**, "Incompressible turbulent flow: partial average based theory and applications," Journal of Hydraulic Research, Vol.43, No.4, pp.399-407, 2005
- G. Gao, Ge, and **Y. Yong**, "Partial average based equations of incompressible turbulent flow," International Journal of Nonlinear Mechanics, Vol. 39, No.9, pp.1407-1419, 2004.
- G. Gao, and **Y. Yong**" "The United Modeling Theory for Mean Flow and Coherent Flow of Incompressible Turbulence, "Journal of Aerospace Power, Vol. 15, No.1, pp.1-11, 2000.
- **Y. Yong**, "Response of Pipeline Structure Subjected to Earthquake Ground Motion," Engineering Structures, Vol.19, No.8, pp.679-684, 1997.
- **Yong, Y.**, Zhang, R.C and Yu, J., "Motion of Foundation on a Layered Medium, Part I: Impedance Characteristic and Part II: Response Analysis," Soil Dynamics and Earthquake Engineering. Vol.16, pp.295-316, 1997.
- Gao, G. and **Yong, Y.**, 1996, "Transition Simulation Using GLM-EM Based Closed Equations of Turbulence," Journal of Aerospace Power, Vol.11, No.4, pp.401-406
- **Yong, Y.**, 1995, "Vibration of One-Dimensional Structure with Arbitrary Constraints," Journal of Engineering Mechanics, Vol.121, No.6, pp.730-736.
- Zhang, R.C. and Yong, Y., 1994, "Influence Function for a Layered Medium with a Buried Distributed Source," Journal of Applied Mechanics, Vol.61, No.4, pp.990-992.
- **Yong, Y.** and Lin, Y.K., 1992, "Dynamic Response Analysis of Truss-Type Structural Networks - a Wave Propagation Approach," Journal of Sound and Vibration, Vol.156, No.1, pp.27-45.
- Zhang, R.C., **Yong, Y.** and Lin, Y.K., 1991, "Earthquake Ground Motion Modeling: Deterministic Point Source - Part I Stochastic Line Source - Part II," **Journal of Engineering Mechanics**, Vol.117(9), pp.2114-2148.
- **Yong, Y.** and Lin, Y. K., 1990, "Dynamics of Complex Truss-Type Space Structures," **AIAA Journal**, Vol.28(7), pp.1250-1258.
- **Yong, Y.** and Lin, Y. K., 1989, "Propagation of Decaying Waves in Periodic and Piece-Wise Periodic Structures of Finite Length," Journal of Sound and Vibration, Vol.129, No.4, pp.99-118.

1. Name

Brian W. Benscoter, Ph.D., E.I.
Associate Professor, Department of Biological Sciences, Florida Atlantic University

2. Education

Ph.D. in Plant Biology
Southern Illinois University, Carbondale, IL (December 2007)

Master of Science in Biology
Villanova University, Villanova, PA (December 2002)

Bachelor of Science in Biology, Minors in Philosophy and Sociology
Villanova University, Villanova, PA (May 2000)

3. Academic experience

2016-present	Associate Professor of Plant Ecology, Florida Atlantic University
2014-2015	National Academies Education Fellow in the Life Sciences
2013-2014	Researcher of the Year (Asst. Professor), Florida Atlantic University
2010-2016	Assistant Professor of Plant Ecology, Florida Atlantic University
2003-2006	Science To Achieve Results (STAR) Fellow, US Environmental Protection Agency

4. Non-academic experience

Not applicable

5. Certifications or professional registrations

Certified Fire Ecologist	Association for Fire Ecology	2018-present
Certified Airboat Operator (AOCC)	US Department of Interior	2014-present

6. Current membership in professional organizations

- Society of Wetland Scientists, member since 2001
- Ecological Society of America, member since 2001
- American Geophysical Union, member since 2001
- Association for Fire Ecology, member since 2015
- International Association of Wildland Fire, member since 2017

7. Honors and awards

- Nominee, Mentor of the Year-High School Level, Broward County Public Schools, 2018
- Researcher of the Year (Assistant Professor), Florida Atlantic University, 2013-2014
- Outstanding Graduate Student Researcher, Southern Illinois University, 2006.

8. Service activities (within and outside of the institution)

- FAU Division of Research, Diving and Boating Safety Committee Chair (2019-present)
- FAU Environmental Science Program, Curriculum Committee Chair (2017-present)

- FAU Environmental Science Program, Strategic Planning Committee Chair (2014-present)
- FAU Integrative Biology Doctoral Program, Environmental Science Program Committee (2017-present)
- Society of Wetland Scientists
    - Vice-Chair, South Atlantic Chapter (2017-present)
    - Chair, Biogeochemistry Section (2012-2014)
    - Chair, Peatland Section (2014-2016)
    - Conference Planning Committee (2016-2017)
- Ecological Society of America
    - Meetings Committee (2015-2017)
    - Local Meeting Chair (2016)
- Panelist, US Dept. of Energy, Oak Ridge National Laboratory Triennial Review (2012, 2015, 2019)
- Panelist, NASA Arctic-Boreal Vulnerability Experiment Campaign Evaluation Team (2012)
- Panelist, US Dept. of Energy, Research Priorities in Terrestrial-Aquatic Interfaces Report Team (2016)
- Contributor, 2nd State of the Carbon Cycle Report, US Global Change Research Program (2016-2018)
- Reviewer for five federal agencies or organizations on 20 review panels in the past 8 years

9. Selected publications

Smith, AP, B Bond-Lamberty, **BW Benscoter**, MM Tfaily, CR Hinkle, C Liu, and VL Bailey. 2018. Shifts in pore connectivity from precipitation versus groundwater rewetting increases soil carbon loss after drought. 2017. Nature Communications. doi:10.1038/s41467-017-01320-x

McClellan, M, X Comas, **BW Benscoter**, R Hinkle, and D Sumner. 2017. Estimating belowground carbon stocks in isolated wetlands of the Northern Everglades watershed using ground penetrating radar and aerial imagery. Journal of Geophysical Research-Biogeosciences, 122. doi: 10.1002/2016JG003573

Abbott, B, and others (98 co-authors). 2016. Biomass offsets little or none of permafrost carbon release from soils, streams, and wildfire: an expert assessment. Environmental Research Letters, 11: 034014 ***-Featured in journal's 'Highlights of 2016' collection***

Turetsky, MR, **BW Benscoter**, S Page, G Rein, G van der Werf, A Watts. 2014. Global vulnerability of peatlands to fire and carbon loss. Nature-Geosciences. DOI: 10.1038/NGEO2325

Benscoter, BW, DK Thompson, JM Waddington, MD Flannigan, M Wotton, W DeGroot, and MR Turetsky. 2011. Interactive effects of vegetation, soil moisture, and bulk density on the depth of burning of thick organic soils. International Journal of Wildland Fire. 20 (3): 418-429. ***-One of 10 papers featured in IJWF 25th Anniversary Special Issue***

1. Name

Dale E. Gawlik

2. Education

University of Wisconsin Stevens Point;	B.S. Wildlife	1984
Winthrop College	M.S. Biology	1988
Texas A&M University	Ph.D. Wildlife Science	1994

3. Academic experience

2007-present	Director, Environmental Science Program, Florida Atlantic University
2013-present	Professor, Department of Biological Sciences, Florida Atlantic University (advised 10 PhD students, 20 MS students, 35 BS students, and 2 Postdoctoral Associates)
2011-2012	Senior Visiting Fellow, Australian Wetlands and River Centre, University of New South Wales.
2008-2013	Associate Professor, Department of Biological Sciences, Florida Atlantic University
2003-2008	Assistant Professor, Department of Biological Sciences, Florida Atlantic University
1994	Postdoctoral Research Associate, Texas A&M University
1993-1994	Tom Slick Senior Graduate Fellow, Texas A&M University

4. Non-academic experience

1994-2003 Senior Environmental Scientist, Everglades Division, South Florida Water Mgt. District

5. Certifications

- Certified Senior Ecologist, The Ecological Society of America, 2006 to present.
- Master Bird Bander, U.S. Geological Survey Bird Banding Lab, 2004 to present.
- Certified Wildlife Biologist, The Wildlife Society, 1999 to present.

6. Current membership in professional organizations

- American Society for Ornithology
- Association of Field Ornithologists
- Ecological Society of America
- Florida Chapter of The Wildlife Society
- Florida Ornithological Society
- IUCN Heron Specialist Group
- IUCN Stork, Ibis, and Spoonbill Specialist Group
- The Wildlife Society
- Waterbird Society
- Wilson Ornithological Society

7. Honors and awards

- *Keynote address*, Florida Ornithological Society, Davie, FL, 2018
- *Plenary Speaker*, Annual Conference of the Florida Chapter of The Wildlife Society, Gainesville, FL, 2017.
- *Researcher of the Year* (Professor level), Charles E. Schmidt College of Science, Florida Atlantic University, 2016.
- *Researcher of the Year* (Associate Professor level), Florida Atlantic University, 2009.
- *Plenary speaker, Symposium on Coastal Restoration and Enhancement through Science and Technology (CREST), Thibodaux, LA, 2003.*
- *Elective Member*, American Ornithologists Union, 2002 to present.

8. Select service activities

Elected positions:

- *Councilor*, Waterbird Society, 2017-2019
- *Secretary*, Association of Field Ornithologists, 2016-2017, 2018-2019
- *Councilor*, Wilson Ornithological Society, 2016-2018.
- *Councilor*, Association of Field Ornithologists, 2013-2016.
- *President-elect, President, Past President, Vice President, Secretary, Representative to the Southeast Section of The Wildlife Society, Executive Board Member at Large*, Florida Chapter of The Wildlife Society, 2001 -2014.
- *Chair Elect, Chair, Past Chair,* Restoration Working Group, The Wildlife Society, 1999-2003.
- Other service activities:
- *Steering Committee*, IUCN Heron Specialist Group Symposium, 2016
- *Research Advisory Council*, Rookery Bay National Estuarine Research Reserve, 2015.
- *Program Committee*, 2015, 2017, and 2019 Greater Everglades Ecosystem Restoration Conferences, 2013-2019.
- *Science Advisory Committee*, Gulf Coast Bird Observatory, Lake Jackson, TX, 2012–15.
- *Science Advisory Committee* for the Whooping Crane Eastern Partnership, U.S. Fish and Wildlife Service, 2011-present.
- *Dissertation Reviewer*, University of New South Wales, Sydney, Australia, 2010.
- *Dissertation Reviewer*, University of New England, Armidale, Australia, 2010.
- *Chair,* Boating Diving Safety Committee, Florida Atlantic University, 2017-2018
- *Search Committee* for Director of Harbor Branch Oceanographic Institute, Florida Atlantic University, 2015-2016.

9. Select peer-reviewed publications (9 recent out of 71 total)

- Calle, L., L. Green, A. Strong, and D. E. Gawlik. 2018. Time-integrated habitat availability is a resource attribute that informs patterns of use in intertidal areas. Ecological Monographs 88: 600-620.
- Klassen, J. A. and D. E. Gawlik. 2018. Does a long-term shift in Wood Stork diet foreshadow adaptability to human-induced rapid environmental change? Journal of Field Ornithology 89:126-139.
- Chastant, J. E. and D. E. Gawlik. 2018. Water-level fluctuations influence wading bird prey availability and nesting in a managed lake ecosystem. Waterbirds 41: 35-45.
- Klassen, J. A. and D. E. Gawlik. 2017. Tradeoffs between fine-scale site measurements and coarse sensory data for long-term monitoring of pulsed wetlands. Freshwater Biology 62: 649-663.
- Chastant, J. E., M. L. Petersen, and D. E. Gawlik. 2017. Nesting substrate and water-level fluctuations influence wading bird nesting patterns in a large shallow eutrophic lake. Hydrobiologia 788: 371-383.
- Klassen, Jessica A., D. E. Gawlik, and P. C. Frederick. 2016. Linking Wading Bird Prey Selection to Number of Nests. Journal of Wildlife Management 80: 1450-1460
- Botson, Bryan A., D. E. Gawlik, and J. C. Trexler. 2016. Mechanisms that generate resource pulses in a fluctuating wetland. PLoS ONE 11: e0158864.
- Calle, L., D. E. Gawlik, Z. Xie, L. Green, B. Lapointe, and A. Strong. 2016. Effects of tidal periodicities and diurnal foraging constraints on the density of foraging wading birds. Auk 133: 378-396.
- Beerens, J. M., P. C. Frederick, E. G. Noonburg, and D. E. Gawlik. 2015. Determining habitat quality for species that demonstrate dynamic habitat selection. Ecology and Evolution 5: 5685-5697.

10. Select professional development activities

- *Co-organized symposium,* System-wide science: translating a trophic hypothesis foundation for restoration. Greater Everglades Ecosystem Restoration Conference, Coral Springs, FL, 2015
- *Co-organized symposium*, Biology of the Great Egret. Waterbird Society Conference, La Paz, Mexico, 2015.
- *Panelist* for evaluation of Society of Ecological Restoration International Primer on Ecological Restoration. Conference on Ecological and Ecosystem Restoration, New Orleans, 2014.

1. Name

Louis A. Merlin, Ph.D., AICP

Assistant Professor, School of Urban and Regional Planning, Florida Atlantic University

2. Education

Ph.D. in Urban and Regional Planning
University of North Carolina, Chapel Hill, 2014

Master of City and Regional Planning
Georgia Institute of Technology, 2004

Master of Science in Operations Research
Georgia Institute of Technology, 1999

Bachelor of Arts in Mathematics, Cum Laude
Yale University, 1994

3. Academic experience

2016- present Assistant Professor, School of Urban and Regional Planning, College of Design and Social Inquiry, Florida Atlantic University

2014-2016 Dow Sustainability Postdoctoral Fellow, Taubman College of Architecture and Urban Planning, University of Michigan

4. Non-academic experience

Associate, EDAW, Inc., Atlanta, GA, 2003 – 2009

5. Certifications or professional registrations

American Institute of Certified Planners, 2007 - Present

6. Current membership in professional organizations

American Planning Association

7. Honors and awards

STRIDE University Transportation Center Student of the Year, 2015
Graduate and Professional Student Federation Excellence in Mentoring Award, 2014
Doctoral Fellow, Royster Society of Fellows, 2009 – 2014
EDAW Early Career Leadership Development Forum, 2008

Service activities (within and outside of the institution)

Transportation and Land Development Committee (ADD30), Transportation Research Board, The National Academies of Science, Engineering, and Medicine
Florida Atlantic University, School of Urban and Regional Planning
School of Urban and Regional Planning Diversity Committee
Master of Urban and Regional Planning Program Committee
College for Design and Social Inquiry
Faculty Steering Committee
Undergraduate Program Committee
Mentor through FAU's The Mentoring Project

9. Selected publications

Levine, J., Grengs, J., and Merlin, L.A. From Mobility to Accessibility: Transforming Urban Transportation and Land-Use Planning. Cornell University Press.
Merlin, L.A., Levine, J., and Grengs, J. (2018). Accessibility analysis for transportation

projects and plans. Transport Policy. 69, 35-48. DOI: https://doi.org/10.1016/j.tranpol.2018.05.014.
Merlin, L.A., and Hu, L. (2017). Does competition matter in measures of job accessibility? Explaining employment in Los Angeles. Journal of Transport Geography. 64, 77-88. DOI: http://dx.doi.org/10.1016/j.jtrangeo.2017.08.009.
Merlin, L.A. (2017). Comparing automated shared taxis and conventional bus transit for a small city. Journal of Public Transportation. 20(2), 19-39. DOI: http://dx.doi.org/10.5038/2375-0901.20.2.2.
Levine, J., Merlin, L.A., and Grengs, J. (2017). Project-level accessibility analysis for land-use planning. Transport Policy. 53, 107-119. DOI: http://doi.org/10.1016/j.tranpol.2016.09.005.
Merlin, L.A. (2017). A portrait of accessibility change for four US metropolitan areas. Journal of Transport and Land Use. 10(1), 309-336. DOI: http://dx.doi.org/10.5198/jtlu.2015.808.
Merlin, L.A. (2014). Measuring community completeness: Jobs-housing balance, accessibility, and convenient local access to nonwork destinations. Environment and Planning B. 41(4), 736-756. DOI: https://doi.org/10.1068/b120010p.
Song, Y., Merlin, L.A., and Rodriguez, D. A. (2013). Comparing measures of urban land use mix. Computers, Environment, and Urban Systems. 42, 1-13. DOI: https://doi.org/10.1016/j.compenvurbsys.2013.08.001.

1. Name

Diana Mitsova, Ph.D.
Associate Professor & Director, Visual Planning Technology Lab, School of Urban & Planning, Florida Atlantic University

2. Education

Ph.D., Regional Development Planning
University of Cincinnati 2008

Masters of Public Affairs
Indiana University Purdue University Indianapolis, School of Public and Environmental Affairs, 2003

3. Academic experience

2016-present	Associate Professor and Director, Visual Planning Technology Lab, School of Urban and Regional Planning, Florida Atlantic University
2018-present	Affiliate Associate Professor in Geosciences, Florida Atlantic University
2014-present	Associate Professor, School of Urban & Regional Planning, Florida Atlantic University
2008-2014	Assistant Professor, School of Urban & Regional Planning, Florida Atlantic University
2004-2008	Graduate Research Assistant, University of Cincinnati
2003-2004	Program Director I / Research Analyst, State of Indiana, Indianapolis
2001-2003	Graduate Research Assistant, Center for Urban Policy and the Environment, Indianapolis

4. Non-academic experience

5. Certifications or professional registrations

6. Current membership in professional organizations

7. Honors and awards

8. Service activities

- **PRAISys (**Probabilistic Resilience Assessment of Interdependent Systems) - A computational platform for probabilistic analysis of infrastructure interdependencies (under development) – a collaborative CRISP 2 Project funded by the National Science Foundation involving Lehigh University, Florida Atlantic University, and Georgia State University.
- **ADAPT: Adaptation Design and Planning Tool for Urban Areas in the Coastal Zone, a collaborative project involving architects, urban planners, civil engineers, and environmental scientists from Florida Atlantic University. The project was awarded the 2018 National AIA Institute Honor Award** for Regional and Urban Design **by the American Institute of Architects.**
- **SE Florida Living Shorelines** Suitability Analysis Tool – an interactive mapping tool available through the coastalresilience.org website (http://maps.coastalresilience.org/seflorida/) developed in collaboration with The Nature Conservancy and the Shoreline Resilience Working Group of the Regional Climate Compact.
- **Sea Level Rise Vulnerability Framework for USGS Ecosystem Portfolio Model**, a collaborative project between FAU School of Urban and Regional Planning and USGS. A white paper for **SUS Climate Change Task Force: Science addressing the needs of Florida Agencies, Industry and Citizenry (**http://floridaclimate.org/whitepapers/**).** A White Paper for the Kresge Foundation**, Impacts of Sea Level Rise on Public Health in Southeast Florida** (http://flhealthinnovation.org/sea-level-rise-mapping).
- A peer reviewer/panelist for the **NSF-FEWS 2016**, **USEPA STAR 2015 Fellowship**

Applications: EPA-2015-STAR --F1 Sustainable and Healthy Communities- Multidisciplinary Approaches To Optimize Decision Outcomes, September 10-11, 2015, virtual panel; Site visit team, **NSF 3-Gen Engineering Research Centers** (ERC) Program, Atlanta, GA, November 7-8, 2016. A peer reviewer/**USEPA STAR 2013 Fellowship Applications** – B2 Global Change, panel meetings March 13-15, 2013, Washington, DC; **USEPA STAR 2012 Fellowship Applications** – A3-2 Social Sciences, panel meetings March 8-9, 2012, Washington, D; Reviewer of six chapters of the textbook *Global Climate Change: A First Course*, Jones and Bartlett Publishers (2010).

- *To date, I have mentored 11 PhD students in Geosciences (either as a chair or a committee member), 1 PhD student in Urban Planning, 1 PhD student in Computer Engineering, 6 Master's thesis students, and 4 undergraduate honors theses.*

9. Selected publications:

- **Mitsova, D.** & Esnard. A-M. (2019). *Geospatial Applications for Climate Adaptation Planning*. New York, NY & Abingdon, UK: Routledge /Taylor & Francis.
- **Mitsova, D**. (2019). Supporting natural hazards management with geospatial technologies. In *Oxford Research Encyclopedia of Natural Hazard Science,* Oxford University Press. doi: http://dx.doi.org/10.1093/acrefore/9780199389407.013.283.
- **Mitsova, D**., Escaleras, M., Esnard, A-M, Sapat, A., Lamadrid, A.J. (2019). The Effects of Infrastructure Service Disruptions and Socioeconomic Vulnerability on Hurricane Recovery. *Sustainability, 11(2), 516-532; doi:3390/su11020516* (Special issue on *Natural Disasters and Economics*).
- **Mitsova, D**., Esnard, A.-M., Sapat, A., & Lai, B.S. (2018). Socioeconomic vulnerability and electric power restoration timelines in Florida: The case of Hurricane Irma. *Natural Hazards,* https://doi.org/10.1007/s11069-018-3413-x.
- **Mitsova, D**. (2018). Integrative Interdisciplinary Frameworks for Critical Infrastructure Interdependency Analysis, *Risk Analysis*, DOI: 10.1111/risa.13129. [Epub ahead of print].
- **Mitsova, D.**, C. Bergh, G. Guannel, C. Lustic, M. Renda, J. Byrne, A. Graves, S. Reed, R. Alhawiti, K. Cresswell, and A. Goldberg. (2018). Spatial Decision Analysis of Nature-Based Shoreline Stabilization Options in South Florida's Estuarine Environments, *Journal of Environmental Planning and Management*, DOI: https://doi.org/10.1080/09640568.2017.1398637
- **Bloetscher, F**., Polsky, C. Bolter, K., **Mitsova, D**., Palbicke Garces, K., King, R., Cosio-Carballo, I., Hamilton, K. (2016). Assessing Potential Impacts of Sea Level Rise on Public Health and Vulnerable Populations in Southeast Florida and Providing a Framework to Improve Outcomes. *Sustainability*, *8*(4), 315; doi:10.3390/su8040315.
- Labiosa, W.B., W.M. Forney, A-M. Esnard, D. **Mitsova**, R. Bernknopf, P. Hearn, D. Hogan, L. Pearlstine, D. Strong, H. Gladwin, and E. Swain. (2013). The South Florida Ecosystem Portfolio Model: An Integrated Multi-criteria Scenario Evaluation Web Tool for Participatory Land-Use Planning in the Face of Sea Level Rise, *Journal of Environmental Modeling and Software*, 41: 210-222, (http://dx.doi.org/10.1016/j.envsoft.2012.10.012).
- **Mitsova, D**. and A.M. Esnard. (2012). Holding Back the Sea: An Overview of Shore Zone Management and Research Needs. *Journal of Planning Literature,* 27(4): 446 - 459.
- **Mitsova, D**., A.M. Esnard, and Y. Li. (2012). Using Enhanced Dasymetric Mapping Techniques to Improve the Spatial Accuracy of Sea Level Rise Vulnerability Assessments, *Journal of Coastal Conservation: Planning and Management,* 16(3): 355-372.
- Esnard, A.M., A. Sapat, and **D. Mitsova**. (2011). An Index of Relative Displacement Vulnerability to Hurricanes. *Natural Hazards*, 59(2): 833-8

1. Name

John L. Renne, Ph.D., AICP

Associate Professor, Director for Urban and Environmental Solutions
Program Coordinator, Bachelor of Urban Design and Bachelor of Urban and Regional Planning,
School of Urban & Regional Planning, Florida Atlantic University

2. Education

Ph.D. in Urban Planning and Policy Development
Major Fields: Transportation and Land Use Planning
Edward J. Bloustein School of Planning and Public Policy
Rutgers University, New Brunswick, New Jersey, 2005

Master of Urban and Regional Planning (Outstanding Student)
Concentration: Economic Development
College of Architecture and Planning
University of Colorado at Denver, 2000

Bachelor of Environmental Design (with Honors)
Major: Urban Planning and Design
Minor: Economics
College of Architecture and Planning
University of Colorado at Boulder, 1999

3. Academic experience

January 2016 – present Associate Professor, School of Urban and Regional Planning, Florida Atlantic University
January 2016 – present Coordinator, Undergraduate Programs, School of Urban and Regional Planning, Florida Atlantic University
March 2016 – present Director, Center for Urban and Environmental Solutions, School of Urban and Regional Planning, Florida Atlantic University
April 2013 – present Transport Studies Unit, School of Geography and the Environment, Oxford University, Oxford, United Kingdom
August 2016 – present Honorary Research Associate,
April 2013 – August 2016 Senior Visiting Research Associate
August 2005 – December 2015 Department of Planning and Urban Studies and Transportation Studies Program, Merritt C. Becker Jr. University of New Orleans Transportation Institute, University of New Orleans
August 2005 – August 2011 Assistant Professor
August 2011 – December 2015 Associate Professor
August 2005 – August 2011 Associate Director, UNO Transportation Center
August 2011 – December 2015 Director, Merritt C. Becker Jr. UNO Transportation Institute August 2014 – August 2015 Associate Provost for Urban Initiatives

4. Non-academic experience

2014 – Present Creator and Director, TOD Index

April 2007 – Present Managing Director, The TOD Group & Denver TOD Fund,

5. Certifications or professional registrations

American Institute of Certified Planners (AICP)

6. Current membership in professional organizations

Transportation Research Board; American Planning Association; Urban Land Institute;

7. Honors and awards

Available upon request

8. Service activities (within and outside of the institution)
Available upon request

9. Selected publications

- **John Renne** and Billy Fields (Eds.). Transport Beyond Oil. Washington, D.C.: Island Press, 2013.
- Carey Curtis, **John Renne** and Luca Bertolini (Eds.). Transit Oriented Development: Making It Happen. Surrey, UK: Ashgate, 2009.
- **John Renne** and David Listokin. "The opportunities and tensions of historic preservation and transit oriented development (TOD)." Cities. Vol. 90, pp. 249-262, 2019.
- **John Renne**. "Emergency evacuation planning and policy for carless and vulnerable populations in the United States and United Kingdom." International Journal of Disaster Risk Reduction. Vol. 31, pp. 1254-1261, 2018.
- **John Renne**. "Transit-oriented development and ports: A national analysis in the United States." The Journal of Transport and Land Use. Vol. 11, No. 1, pp. 297-304, 2018.
- **John Renne** and Tara Tolford. "A planning tool for evaluating vehicles miles travelled and traffic safety forecasts of growth management scenarios: A case study of Baton Rouge and New Orleans." Transportation Research Part D, Vol. 59, pp. 237-245, 2018.
- **John Renne**, Shima Hamidi and Reid Ewing. "Transit Commuting, the Network Accessibility Effect, and the Built Environment in Station Areas across the United States." Research in Transportation Economics. Vol. 60, pp. 35-43, 2016.
- **John Renne**, Tara Tolford, Shima Hamidi and Reid Ewing. "The Cost and Affordability Paradox of Transit-Oriented Development: A Comparison of Housing and Transportation Costs across Transit-Oriented Development, Hybrid and Transit-Adjacent Development Station Typologies." Housing Policy Debate. Vol. 26. No. 4-5., pp. 819-834, 2016.

10. Professional development activities

Co-Founder, National Evacuation Conference; Organizer, TOD Academy; Chair, TRB Transportation and Land Development Committee; Chair, Mobility Committee, Urban Land Institute, Southeast Florida and Caribbean Council; Board, Palm Beach County Planning Congress, Board Chair, Evacuteer.org

1. Name
Tara L. Root, Ph.D.
Associate Profesor, Department of Geosciences, Florida Atlantic University

2. Education
Ph.D., Geology
University of Wisconsin Madison, Wisconsin, 2005

M.S., Geology
University of Wisconsin Madison, Wisconsin, 2000

B.S., Geological Engineering
Colorado School of Mines Golden, Colorado, 1998

3. Academic experience

2013 – present	Associate Professor and Manager Water Analysis Lab Core Facility, Department of Geosciences, Florida Atlantic University
2006 – 2013	Assistant Professor, Department of Geosciences, Florida Atlantic University
2005 – 2006	Visiting Assistant Professor, Department of Geosciences, Florida Atlantic University

4. Non-academic experience
Fellow, 1999-2002, Office of Civilian Radioactive Waste Management Fellowship Program

5. Certifications or professional registrations

6. Current membership in professional organizations
- Geological Society of America
- South Florida Hydrologic Society

7. Honors and awards
FAU excellence and innovation in undergraduate teaching award (2013)

8. Service activities (within and outside of the institution)
- Editor of The Hydrogeologist, Newsletter for the Hydrogeology Division of the Geological Society of America (2019)
- Member of steering committing for forming FAU chapter of the Association for Women Geologist (2018 – present)
- Student Outreach Coordinator for the Hydrogeology Division of the Geological Society of America (2016 – present)
- Geological Society of America Campus Representative (2008 – present)
- Member College of Science Seed Grant Review Panel (2018 – present)
- Member Department of Geosciences Personnel Committee (2013 – present)
- Member M.S. Geosciences Admissions Committee (2018 – present)
- Member M.S. Environmental Sciences Admissions Committee (2018 – present)
- Co-chair Environmental/Marine Geology Faculty Search Committee (present)

8. Selected publications
- Weisner, M., **Root, T.**, Harris, M., Liu W., in review. Tap water perceptions and socioeconomics in Palm Beach County, FL. Why are the poor so dissatisfied? *Sustainable Production and Consumption.*
- Survis, F.D. and **Root, T.L.**, 2017. The rain-watered lawn: Informing effective lawn watering

behavior. *Journal of Environmental Management*, 199:109-115.

- Survis, F.D., **Root, T.L.**, and Pathak, C.S., 2017. Identifying seasonal opportunities to save water: Using weekly rainfall and evapotranspiration patterns to evaluate outdoor water restriction policy in South Florida. *Water Conservation Science and Engineering*, 2(4):133-143.
- **Root, T.L.**, 2014. Review of Groundwater for the 21st Century: A Primer for Citizens of Planet Earth. *Groundwater*, 52:647-648.
- **Root, Tara**, 2013. Book Review: Albert C. Hine, Geologic History of Florida, Major Events that Formed the Sunshine State. *The Florida Geographer*, 44, 54-55.
- **Root, Tara**, 2013. Book Review: Robert Brinkmann, Florida Sinkholes, Science and
- Policy. *The Florida Geographer*, 44, 56.
- Kuhn, T. and **Root, T.**, 2012. Environmental controls on the distribution and vigor of an endangered grass (*Panicum abscissum* Swallen). *Papers of the Applied Geography Conferences,*35:403-411.
- Survis, F. and **Root, T**. 2012. Evaluating the effectiveness of water restrictions: A case study from southeast Florida. *Journal of Environmental Management* 112:377-383.
- **Root, T.**, Gotkowitz, M., Bahr, J., and Attig, J. 2009. Arsenic geochemistry and hydrostratigraphy in Midwestern U.S. glacial deposits. *Ground Water* 48:903-912.
- Lakhan, S., **Root, T.**, and Fadiman, M. 2009. Household water in northern Trinidad: Source, collection, storage, and socioeconomics. *The Florida Geographer* 40:48-61.
- **Root, T.** 2008. Arsenic speciation and form in a glacial aquifer in the Midwestern United States. *Papers of the Applied Geography Conferences*, 31:25-33.
- **Root, T.** and Carlson, E. 2007. Water quality and hydrology of an environmental preserve in Palm Beach County, Florida. *Papers of the Applied Geography Conferences*, 30:457-465.
- **Root, T.**, Bahr, J., and Gotkowitz, M.., 2005. Geochemical and environmental controls on arsenic in ground water in southeastern Wisconsin, *in* O'Day, P. et al., Advances in Arsenic Research, American Chemical Society Symposium Series, 915, pp. 161-173.

9. Professional development activities

- Horiba Jobin Yvon Ultima 2 ICP Spectrometer Training (1 wk) (fall 2013)
- NASA forum on higher education: building collaborations among colleges of science, engineering, and education (2009)
- On the Cutting Edge, Early Career Geoscience Faculty: Teaching, Research, and Managing Your Career Workshop (2007)

1. Name:

Zhixiao Xie, Ph.D.
Professor and Chair, Department of Geosciences, Florida Atlantic University

2. Education
Ph.D., Geography
State University of New York at Buffalo, 2002

M.S., Computer Science & Engineering
State University of New York at Buffalo, 2002

M.S., in Ecology
Chinese Academy of Sciences, China, 1993

B.S., Geography
Peking University, China, 1990

3. Academic experience

05/2015-present	Chair, Geosciences Department, Florida Atlantic University, Boca Raton, FL
08/2014-present	Professor, Geosciences Department, Florida Atlantic University, Boca Raton, FL
09/2014-05/2015	Associate Dean for Research and Partnership Initiatives, College of Science, Florida Atlantic University, Boca Raton, FL
09/2011-05/2015	Director of Center for GIS (Geographic Information Analysis and Modeling)
08/2009-07/2014	Associate Professor, Geosciences Department, Florida Atlantic University, Boca Raton, FL
08/2003-07/2009	Assistant Professor, Geosciences Department, Florida Atlantic University, Boca Raton, FL

4. **Non-academic experience**

5. **Certifications or professional registrations**

6. **Current membership in professional organizations**
- Association of American Geographers (AAG)
- Chinese Professionals in Geographic Information Sciences (CPGIS)

7. Honors and awards

8. Service activities (within and outside of the institution)
- 2014-present College of Science EXCOM
- 2013-2014 Chair of FAU Science College Master Researcher Committee
- 2013-2015 Chair of FAU Science College Graduate Program Committee
- 2011-2012 Member, college Master Researcher program
- 2007-2010 Member of Academic Program Committee for Environmental Sciences
- 2018 (SP) Program review team for Department of CEGE
- 2015 (SP) University Honors Council
- 2014-2015 College of Science Representative, FAU Council on International Education
- 2014-2015 FAU HBOI IRL Observatory Science and Technology Advisory Committee
- 2013-2015 Member, FAU University Graduate Council
- 2013-2015 Member, FAU Graduate Programs Committee
- 2013-2015 Member, FAU Research Committee

- 2013-present Invited Editorial Advisory Board member of the ISPRS Journal of Photogrammetry and Remote Sensing
- 2018 Member of program committee for Fifth International Workshop on Earth Observation and Remote Sensing Applications (EORSA 2018)
- 2016 Member of program committee for Fourth International Workshop on Earth Observation and Remote Sensing Applications (EORSA 2016)
- 2014 Member of program committee for Third International Workshop on Earth Observation and Remote Sensing Applications (EORSA 2014)
- 2014 Session Chair -Vehicular Transportation Outcomes, AAG 2014
- 2013 Co-Organizer of three sessions for AAG 2013 titled "Remote Sensing and GIS Techniques in Wetland and Coastal Ecosystems" and session chair for one of the session
- 2012 Member of program committee (Abstract Committee) for Second International Workshop on Earth Observation and Remote Sensing Applications (EORSA 2012)

9. Selected publications

- Forbes, D. and Z. Xie, 2018. Identifying Process Scales in the Indian River Lagoon, Florida using Wavelet Transform Analysis of Dissolved Oxygen, Ecological Complexity, 36: 149-167.
- Xie Z., and Ziegler H, 2017. Mapping Urban Population at Housing Unit Level with Integrated Geospatial Technology, Reference Module in Earth Systems and Environmental Sciences, Elsevier, 2017. 16-Sep-16 doi: 10.1016/B978-0-12-409548-9.10420-8.
- Telis, P.A., Xie, Z., Liu, Zhongwei, Li, Yingru, and Conrads, P.A., 2015. The Everglades Depth Estimation Network (Eden) Surface-Water Model, Version 2: U.S. Geological Survey Scientific Investigations Report 2014–5209, 42
- Xie, Z. and J. Yan 2013. "Detect Traffic Accident Clusters with Network Kernel Density Estimation and Local Spatial Statistics: An Integrated Approach". Journal of Transport Geography, 31: 64-71.
- Johnson, B., and Z. Xie, 2013. Classifying a High Resolution Image of an Urban Area Using Super-object Information. ISPRS Journal of Photogrammetry and Remote Sensing, 83: 40-49.
- Xie, Z., C. Zhang, and L. Berry, 2012. Geographically Weighted Modeling of Surface Salinity in Florida Bay Using Landsat TM Data. Remote Sensing Letters, 4: 76-84.
- Xie, Z., L. Pearlstine, and D.E. Gawlik, 2012. Develop a Finer Resolution DEM to Support Hydrological Modeling and Ecological Study in the Northern Everglades Freshwater Wetland. GIScience & Remote Sensing, 49: 664-686.
- Zhang, C. and Z. Xie 2012. Combining Object-based Texture Measures with a Neural Network for Vegetation Mapping in the Everglades from Hyperspectral Imagery". Remote Sensing of Environment, 124: 310-320.
- Xie, Z., and J. Yan, 2008. Kernel Density Estimation of Traffic Accidents in a Network Space. Computers, Environment and Urban Systems, 32: 396-406.
- Xie, Z., C. Roberts, and B. Johnson, 2008. Object Based Target Search Using Remotely Sensed Data: A Case Study in Detecting Invasive Exotic Australian Pine in South Florida. ISPRS Journal of Photogrammetry and Remote Sensing, 63: 647-660

10. Professional development activities

- AAAS Communicating Science Workshop, Feb. 28, 2018
- "Department Chairpersons Workshop", FSU Institute for Academic Leadership, Mission Inn Resort, Howey-in-the-Hills, Florida, Oct. 1- 4, 2017
- "Department Chairpersons Workshop", FSU Institute for Academic Leadership, Mission Inn Resort, Howey-in-the-Hills, Florida, June 4 – 7, 2017
- "Essentials of Academic Leadership: Augmentation", FAU Center for Leadership and Professional Development, Boca Raton, FL, Dec 01, 2014.
- "Essentials of Academic Leadership" workshop, FAU Center for Leadership and Professional Development, Boca Raton, FL, Oct 06, 2014.

APPENDIX F

STRATEGIC PLAN (2018-2022)
Department of Civil, Environmental and Geomatics Engineering
(Approved by Faculty on April 9, 2018)

Vision
To be nationally recognized as an eminent engineering program with excellence in education, research and community engagement.

Mission
To provide our engineering students with a high-quality education on fundamental concepts and engineering design, and to conduct cutting-edge research in urban mobility/infrastructure and water resources/environmental sustainability in state-of-the-art learning environments to benefit communities in Florida and beyond.

Listed goals for the Strategic Plan (2018) will be revisited and revised, as necessary on a biannual basis. Measures of success will be collected and reported annually.

Goal 1 – Be Nationally Recognized for High-Quality Research

- **Objective 1.1 – Support existing centers and labs in the Department and develop new externally funded research centers**
  - **Strategy 1.1.1** – Evaluate existing research centers and labs in the Department and develop a plan to enhance productivity and visibility
    - *Measure of success: All existing centers and labs in the department meet performance metrics*
    - Plan:
      - Develop appropriate performance metrics for the research centers and labs of the Department.
  - **Strategy 1.1.2** – Sustain existing Department centers and labs
    - *Measure of success: All centers in the Department must have active and continuing research funding, support graduate students and provide ongoing outreach through technical publications and periodic seminars.*
    - Plan:
      - Reorganize existing research centers and labs with deficient performance
      - Oversight of existing research center/lab activities including partner institutions to maintain research and scholarly activities
      - Develop collaboration among existing Department research centers and across the College and University
      - Prioritize technical publications, outreach, and other scholarly activities related to research centers and labs in the Department
      - Organize an outreach seminar annually per center (one option would be "Lunch and Learn" seminar with professional development hours (PDHs))
  - **Strategy 1.1.3 –** Secure funding for new centers in the emerging areas of research
    - *Measure of success: One new State or federally funded center of excellence within a five-year period*
    - Plan:
      - Identify emerging research areas of national significance

- Identify potential partners within and outside university
- Develop multidisciplinary, multiple college, multi-university proposals

- **Objective 1.2 – Maintain a sustainable funding level to support faculty, research, and teaching assistants**
  - **Strategy 1.2.1 –** Implement research incentive program
    - *Measure of success: Percentage of faculty taking advantage of incentive program > 50%*
    - Plan:
      - Identify research funding requirements for faculty members to achieve their stated goals
      - Evaluate and adjust teaching load and TA support based on the research productivity
      - Identify funding mechanisms that help faculty achieve research funding goals through external fundraising, securing gifts from foundations, providing professional development training, certificate programs, and special events.
      - Provide faculty professional development incentives (for licensure, continuing education, committee membership in professional societies, attendance to major conferences, etc.)
  - **Strategy 1.2.2 –** Recruit additional faculty to strengthen emerging areas of potential research funding, such as environmental, transportation, and structural engineering
    - *Measure of success: Number of research-active faculty > 75%*
    - Plan:
      - Evaluate and address immediate strategic faculty hiring needs in the areas of environmental and transportation. Specifically, focus next two faculty hires:
        1) in air pollution to interface between the UTC/urban mobility focus group and the environmental focus group (note there is significant regulatory funding at the state and federal level that are available for research related to air pollution from vehicles, multi-modal transportation systems, landfills, treatment facilities and contributions to coastal waterways from fallout), and
        2) in transportation to strengthen areas outside of freight mobility and intelligent transportation systems that will make FAU highly competitive for the next round of UTC competition
      - Address future strategic faculty hiring needs in infrastructure and materials which is the area where future innovations will be focused due to changing climate and oceanic water quality considerations
      - For any junior faculty member, the Department will reduce his/her teaching load to one course first semester until they secure tenure. The Department will also provide him/her with travel funds to visit funding agencies.
      - An official mentor will also be assigned to incoming junior faculty. Faculty mentors will receive time release which will be specified in annual assignment
      - Conduct an annual evaluation of strategic hiring needs that aligns with State and national priorities
      - Recruiting non-tenure track faculty such as high calibre visiting/adjunct faculty and research faculty addressing the needs of the Department
  - **Strategy 1.2.3 –** Increase research productivity

        - *Measure of success: External funding support > External funding support in 2018 (target research expenditure $150K/faculty)*
        - Plan:
            - Meet at least once per year with FAU lobbyist
            - Identify potential funding opportunities that meet with faculty strengths to take advantage of the unique combination of faculty expertise to compete for high profile research opportunities like UTC
            - Identify co-collaborators at FAU and other institutions, and host interdisciplinary forum events with potential collaborators from other universities and industry
            - Create periodic research update seminars on current research in the department, and identify areas faculty want to move their research into (i.e. what are they interested in)
            - Engage in local professional societies and local community affairs to learn of opportunities, use contacts to develop potential projects (FDOT, local business, local governments), engage with DAC/GEPAC/AAC on potential areas of collaboration
            - Improve laboratories and address technician hiring needs
- **Objective 1.3 – Increase output of scholarly activities**
    - **Strategy 1.3.1 –** Recognize departmental scholarly work
        - *Measure of success: Number of scholarly work products (books, monographs, and other peer-reviewed publications) > 100*
        - Plan:
            - Encourage faculty to publish books, submit three peer reviewed papers per year, and three conference papers per year
            - Develop incentives for scholarly work, fund support for travel, and use presentations for recruitment purposes
            - Increase the number of journal editors among faculty members
- **Objective 1.4 – Provide state-of-the-art research laboratories and facilities**
    - **Strategy 1.4.1 –** Develop laboratory improvement plan
        - *Measure of success: Graduate exit and faculty survey results show satisfaction in laboratories and facilities*
        - Plan:
            - Develop a laboratory maintenance, acquisition, and upgrade priority list that is updated annually
            - Address the need to hire laboratory technicians
            - Create a fund for laboratory improvement and launch $450K campaign
            - Explore the possibility of utilizing FAU Engineering and Technology Core services
    - **Strategy 1.4.2 –** Hire laboratory technicians for structures and environmental laboratories
        - *Measure of success: Number of laboratory technicians > Two*
        - Plan:
            - Address the need to hire laboratory technicians
            - Create a fund for laboratory improvement, launch $450K campaign
            - Create oversight/safety/security management policies

- **Objective 1.5 – Raise the visibility of the Department in the local and national stages**
  - **Strategy 1.5.1 –** Disseminate faculty research success
    - *Measure of success: Publish Research News Letter twice a year*
    - Plan: Compile and distribute to the professional community a bi-annual newsletter to provide the research community with timely update on the important progresses on research and faculty achievements
  - **Strategy 1.5.2 –** Encourage faculty to serve on national and international level of technical committees
    - *Measure of success: Each faculty serves at least one national or international committee*
  - **Strategy 1.5.3 –** Encourage faculty to publish books, prepare fee-based short courses, webinars (e.g., ASCE) and workshops.
  - **Strategy 1.5.4. –** Provide three professional development training (i.e., Lunch and Learn workshops or meetings), one certificate program and one special event per year.

Goal 2 – Be Nationally Recognized for High-Quality Education

- **Objective 2.1 –** Improve undergraduate curricula to prepare students for a challenging and competitive work environment
  - **Strategy 2.1.1 –** Improve FTIC student retention rate and graduation rate
    - *Measure of Success: 2nd year retention rate for FTIC students ≥ 80%, and four-year graduation rate ≥ 50%*
    - Plan:
      - Closely work with academic advisors to monitor student progress in the areas of math and physics and provide them with proper advice on the career path
      - In addition to the Fundamentals of Engineering (FE) class, students should be exposed to CEGE major areas at early semesters
      - Improve program curricula by increasing the number of technical electives through cross-listing with graduate courses, and provide flexibility in course offerings to students to increase student knowledge in core areas
      - Reevaluate the pre-professional requirements and pre- and co-requisites
  - **Strategy 2.1.2 –** Improve outcomes on the licensing exams (FE/FS)
    - *Measure of Success: Annual FE/FS pass rate for CEGE ≥ 70%*
    - Plan:
      - Include licensure information in all department courses, introduce FE/FS manual on day 1, encourage use of the FE/FS manual for reference materials in course exams, and include FE/FS style questions for part of the grade in the course
      - Increase design content of design core classes (4000-level) in all core areas
      - Conduct annual review of course syllabi and topics taught in all courses to ensure FE/FS topics are being covered
      - Coordinate with professional student clubs in the department to schedule faculty or industry-professional led FE/FS review classes.
  - **Strategy 2.1.3 –** Provide state-of-the-art learning environments and laboratories
    - *Measure of success: Graduate exit survey and course outcome survey results show satisfaction in laboratories and facilities*
    - Plan:

- Provide a laboratory maintenance, acquisition, and upgrade priority list that is updated annually
- Address the need to hire laboratory technicians
- Create a fund for laboratory improvement and launch $450K campaign
- Manage laboratory fee budgets
- Pursue lab certification for establishing core facilities for within the university and for the community

- **Strategy 2.1.4 –** Improve teaching assistant performance
  - *Measure of success: Teaching assistant survey results show satisfaction*
  - Plan:
    - Create a TA selection committee and evaluate the TA requirements of the Department
    - Provide TA training each semester, require lab safety training, require students to attend class they are assigned to (if never took the course), and specify teaching load responsibilities
    - Provide a letter grade on the TA performance from the instructor for each class taught
    - Consider hiring undergraduate graders
- **Strategy 2.1.5–** Increase diversity of faculty and students
  - *Measure of success: Percentage of underrepresented faculty ≥ 30% and Percentage of underrepresented students ≥ 50%*
  - Plan:
    - Implement targeted faculty hiring and targeted student recruitment
    - Create a plan for a professor of practice in the future who can serve as liaison between industry and academia
- **Strategy 2.1.6 –** Increase graduate job placement or continuing education in engineering-related fields
  - *Measure of success: Percentage of graduates employed full-time in engineering or pursuing graduate degree ≥ 90%*
  - Plan:
    - Identify key industry members, elected officials, lobbyists, etc. that should be on the Department Advisory Council (DAC), Geomatics Program Advisory Council (PAC) and Alumni Advisory Councils (AAC)
    - Meet with industry recruiters and employers and Alumni Advisory Council (AAC) regarding lessons learned since graduation and encourage alumni to meet with students regarding importance of education and licensure
    - Invite professionals to evaluate student work, particularly in 4000-level coursework
    - Provide networking opportunities in coursework and engagement activities, and develop a schedule of lectures/talks by professionals from industry on topics related to job search, resume writing and interviewing skills, current trends in the industry, etc.

- **Objective 2.2 – Improve MS curricula**
  - **Strategy 2.2.1 –** Provide flexibility to expand opportunities for working professionals to better prepare them for the career
    - *Measure of success: MS degree completions per year ≥ 20*
    - Plan:

- Create a non-thesis, non-project (course only) option of 30 credits to help students in career advancement and readiness to sit for the PE exam
- Include the possibility of waiving standardized tests (e.g., GRE) on a case-by-case basis
- Increase the number of online courses and explore the possibility of creating online degree programs and weekend programs.
- Contact all students who have completed a minimum of 9 credits of graduate coursework at FAU but did not complete the degree, to notify them that they can switch to the course only option to finish their degree on-line
- Conduct periodic review of the 5-year course offering plan schedule
- Meet with DAC, GEPAC, AAC to encourage their working professionals to pursue graduate study and create active recruiting quotas for DAC, GEPAC, AAC
- Simplify assessment procedures for SACS, ABET, FLBOG, etc.
- Explore the possibility of weekend Master's program.

o **Strategy 2.2.2 –** Develop a marketing plan to support recruiting
  - *Measure of success: MS candidate headcount ≥ 80*
  - Plan:
    - Create marketing materials for MS degree options and faculty research to distribute via website and direct email contacts
    - Encourage working professionals to pursue course-only MS degree option and improve pathway by which working professionals can engage with CEGE faculty through the MS program
    - Advertise end of semester thesis presentations and defenses to encourage undergraduate students to attend
    - Actively use travel dollars for recruiting purposes
    - Schedule open houses/workshops to highlight faculty research
    - Develop web page listing of department alumni, student testimonials, research group presentations to different agencies (e.g., FDOT or others), and lab facilities

o **Strategy 2.2.3** – Increase research output for thesis-option MS students
  - *Measure of success: Each MS candidate publishes one paper per year*
  - Plan:
    - Increase funding for support of MS student RAs
    - Develop a graduate course to help thesis option students with design of experiments, literature review and data analysis
    - Add additional requirements to MSCV (require end of the semester progress presentations to thesis committees with assessment; a Satisfactory grade "S" in thesis credits can only be awarded after the progress presentation, and assessment forms are filed with the CEGE staff, require one research article or conference proceedings paper submitted for publication for each thesis-option student before he/she applies for graduation)
    - Increase participation at local conferences for student/faculty

- **Objective 2.3 – Improve doctoral program by establishing an independent Ph.D. program**

o **Strategy 2.3.1 –** Develop Ph.D. program focused on urban mobility/infrastructure and water resource/environmental sustainability topic areas

        - *Measure of success: Ph.D. degree completions per year ≥ 3*
        - Plan:
            - Prepare Ph.D. program proposal and submit new program for approval
            - Develop means for working professionals to participate in the Ph.D. program
            - Develop research trainee partnerships with industries that hire Ph.D. graduates (i.e., SFWMD, NOAA, USGS, etc.)
            - Increase guaranteed funding for Ph.D. student support
    - **Strategy 2.3.2 –** Develop a marketing plan and implement a recruiting strategy
        - *Measure of success: Ph.D. headcount ≥ 15*
        - Plan:
            - Increase Ph.D. student headcount in OME program until they can be migrated to the independent Ph.D. program
            - Create marketing materials for Ph.D. options and faculty research to distribute via website and direct email contacts
            - Encourage working professionals to pursue Ph.D. and improve pathway by which working professionals can engage with CEGE faculty through the BS/Ph.D. and MS/Ph.D. program
            - Advertise end of semester dissertation presentations and defenses to encourage undergraduates and MS candidates to attend
            - Actively use travel dollars for recruiting purposes
            - Schedule open houses/workshops to highlight faculty research
            - Develop web page listing of department alumni, student testimonials, research group presentations to different agencies (e.g., FDOT or others), and lab facilities
    - **Strategy 2.3.3 –** Increase research output for Ph.D. students
        - *Measure of success: Each Ph.D. student publishes two papers per year*
        - Plan:
            - Increase funding for support of Ph.D. student RAs
            - Develop a graduate course to help thesis option students with design of experiments, literature review and data analysis
            - Add additional requirements to Ph.D. (require end of the semester progress presentations to dissertation committees with assessment; a Satisfactory grade "S" in dissertation credits can only be awarded after the progress presentation, and assessment forms are filed with the CEGE staff, require two research articles or conference proceedings paper submitted for publication for each Ph.D. student before he/she applies for graduation
            - Increase participation at local conferences for student/faculty

Goal 3 – Be Recognized for Community and Industry Engagement

- **Objective 3.1 – Engage community, DAC, GEPAC and AAC in curriculum development, design, research, internships, and job placement**
    - **Strategy 3.1.1 –** Increase activities with DAC, GEPAC, and AAC
        - *Measure of success: Number of event activities > three per year*
        - Plan:
            - Set end-of-semester meetings (at the beginning of each semester) to update DAC, PAC, and AAC on department activities, provide interaction with

graduating students via senior design presentations and encourage industry members to stay for more than one senior design presentation
        - Provide an annual mechanism for curricular input and industry engagement with faculty
        - Encourage fund raising activities via student organizations and other events on campus to host large industry events, such as Infrastructure Night and Concrete Expo
        - Launch $450K campaign to raise funds to improve laboratory conditions
        - Develop/distribute departmental highlights and points of pride each semester on social media
    - **Strategy 3.1.2 –** Organize outreach events to highlight research
        - *Measure of success: Number of events > three*
        - Plan:
            - Encourage faculty speaking engagements guided toward the local community
            - Create events where faculty can discuss research and collaboration with industry partners
            - Encourage faculty to have links to the Department webpages
- **Objective 3.2 – Increase community engagement activity**
    - **Strategy 3.2.1 –** Utilize curriculum to facilitate community interaction with outside mentors/clients
        - *Measure of success: Number of academic service learning offerings > ten*
        - Plan:
            - Encourage academic service learning opportunities
            - Require community engagement discussions/presentations (public hearing, public presentation, or other meeting) with the community involved with class projects
    - **Strategy 3.2.2** – Encourage student organizations to pursue community engagement
        - *Measures of success: Number of students participating > 50%*
        - Plan:
            - Identify community engagement opportunities, post information on department website to encourage students to attend, provide photographs and audio to FAU outreach groups, provide one student group interview with public media per year
            - Encourage students to join at least one professional organization and attend off-campus professional meetings each year, provide FAU branding to highlight event
            - Encourage students/faculty to participate in regional competitions
    - **Strategy 3.2.3 –** Establish partnerships with other universities
        - *Measures of success: Number of partnerships > two*
        - Plan:
            - Encourage national and international peer exchange by inviting national/international scholars for short and long-term visits and encourage our CEGE faculty to do the same
            - Encourage each faculty member to reach out to at least one institution to facilitate MOU process for faculty exchange and graduate student recruitment

APPENDIX G

FAU Proposed Catalog Language

Ph.D. in Transportation and Environmental Engineering

The Department of Civil, Environmental & Geomatics Engineering offers a Doctor of Philosophy (Ph.D.) degree focused on urban mobility and environmental/water resources sustainability. This degree provides students with a fundamental and applied research-based education suitable for seeking employment in industry, government, or academia.

Admission Standards

1. Applicants must have a Master's Degree in Engineering, Science, Urban Planning, Transportation Logistics, or Mathematics from an accredited college or university. A student with outstanding scholastic achievement who holds only a baccalaureate degree may be admitted directly to this Ph.D. program and be eligible to earn the Masters' *en Passant* with a Master of Science with Major in Civil Engineering degree;
2. Applicants must have a 3.0 GPA (on a 4.0 scale) or better in the last 60 credits of work attempted and must have an official transcript forwarded directly to the FAU Graduate College from each college-level institution attended;
3. Applicants must submit the Graduate Record Examination (GRE) score. The GRE requirement can be waived with proof of passing the Fundamentals of Engineering (FE) or Principles and Practice of Engineering (PE) exam. The GRE requirement is waived for applicants that have a Master of Science degree from FAU's College of Engineering and Computer Science.
4. A student from a non-English-speaking country is required to take the Test of English as a Foreign Language (TOEFL) and achieve a score of at least 550 (paper-based) or 213 (computer-based) or 79 (iBT). This requirement may be waived for students who have obtained a prior degree from a U.S. institution;
5. Applicants must submit to the Graduate College at least two letters of recommendation attesting to the student's ability to pursue with distinction a curriculum of advanced study and research in a chosen area;
6. Applicants should abide by the policies and regulations and the graduate admission requirements of the University as outlined in this University Catalog;
7. Conditional admission may be permitted if the above conditions are not met.

Graduation Requirements

The degree will be conferred on candidates who have fulfilled the following requirements:

7. Completed the curriculum for Ph.D. in Transportation and Environmental Engineering:
    - Successful completion of 72 credits of course and dissertation work beyond the baccalaureate degree with a minimum grade of "B." Up to 30 credits of coursework from an approved Master's Degree may be applied;
    - Students must maintain a minimum 3.0 GPA in all coursework attempted for the degree;

Core Course	Sustainability and Pollution Prevention	ENV 6932	3
Core Course	Transportation System Analysis	TTE 6501	3
	2 semesters of Graduate Seminar	CGN 5937	0
	Academic Specialization Electives*		15
	Dissertation (minimum)**		21

*Of the minimum 15 credits of Academic Specialization Electives, at least 12 credits must be at the 6000 level, and no more than 3 credits of directed independent study may be used to satisfy this requirement

** Up to 3 credits of graduate internship (EGN5940) can be used to satisfy the 21-credit dissertation minimum. These credits may not be taken until successfully passing the qualifying exam to enter candidacy

8. Successful completion of a qualifying exam is required prior to completion of 21 credits of coursework beyond the Master's Degree;
9. Successful completion of a dissertation proposal defense is typically required before registering for dissertation credits;
10. Prior to the dissertation defense, the student is required to have published or have accepted for publication a refereed research paper in a field of study deemed acceptable by the dissertation committee. A journal article is preferred, but a peer-reviewed conference paper is also acceptable;
11. Successful completion of an oral defense of the written doctoral dissertation based on original research in the student's area of specialization. The Dissertation/Supervisory Committee, the Department Chair and the Graduate College must have approved the dissertation and oral defense;
12. Complied with the University's Graduate Policies and Regulations and satisfied the University's Graduate Degree Requirements.

Dissertation/Supervisory Committee: Upon acceptance into the Ph.D. Program, a student will select or be assigned an advisor. The student's Ph.D. dissertation committee will have a minimum of four members. Three committee members must be from the FAU graduate faculty or associate graduate faculty according to the FAU Graduate College guidelines, at least one of which is from the Department of Civil, Environmental & Geomatics Engineering. The final member may be a qualified expert from industry or academia with affiliate graduate faculty status. One of the members shall serve as the chair of the supervisory committee. In unusual circumstances, with the approval of the Department Graduate Committee, two members may co-chair; however, off-campus experts or adjunct faculty may not serve as sole committee chair. The Dissertation/Supervisory Committee shall approve the plan of study, monitor academic progress, approve the dissertation topic, prepare, give, and evaluate the Qualifying Exam, evaluate the dissertation defense, and approve the final doctoral dissertation document.

Qualifying Exam: After successful completion of 21 credits of coursework beyond the Master's Degree and within 12 months of completion of graduate coursework, the student will be required to complete a qualifying examination. This written exam is in the field of concentration given by each member of the Dissertation/Supervisory Committee. Performance on any part of the qualifying exam in the judgment of the Dissertation/Supervisory Committee may result in a pass, fail, or fail with the option to re-take. Students may request in writing to repeat the exam. Students failing the Qualifying Exam twice will be dismissed from the program. After passing the Qualifying Exam with the

approval of the dissertation/supervisory committee, a student advances to candidacy.

Proposal Defense: After successful completion of the Qualifying Exam and prior to applying for graduation, the candidate will orally defend the dissertation proposal to the Dissertation/Supervisory Committee for approval.

Dissertation Defense: The doctoral dissertation shall be written in the format specified by the Graduate College. The dissertation must be defended orally and represent an original piece of research that advances the body of knowledge in the field. A written dissertation is submitted to the members of the committee may approve, suggest additional work or reject the dissertation work after the defense.