Introduction and Overview

The aim of teaching, research, and extension in the Department of Plant & Soil Sciences department is to enhance the quality and sustainability of our agricultural, natural and managed landscapes on a scale that ranges from the molecule to the mountain, providing students the preparation needed for success in the sciences, horticultural and agronomic industries. In pursuit of these aims, we will:

- Perform basic and applied research about plants, soils, water, microbes, and their interactions at the level of the molecule and cell, organism and population.
- Integrate basic, translational, and applied research to improve growth, development, and adaptation of plants in varied and changing environments.
- Understand nutrient and trace-element cycling in natural and anthropogenically-impacted environments.
- Educate our stakeholders about the discoveries we make via publications, outreach and extension.

We offer an interdisciplinary program that integrates people, plants, soils and water. This includes understanding and designing sustainable, healthy ecosystems in natural, urban and managed landscapes. We aim to offer focused, rigorous training that requires critical thinking, problem solving, and a translation of knowledge and education to application. The success of our graduates will be measured in their impact in meeting future challenges to agriculture, landscapes, and ecosystems.

Our aim is to define the goals for our department and set the priorities to achieve those goals. The end product will be an improved and enlarged undergraduate program, better-integrated graduate training, and development of novel, externally-funded research activities to advance plant and soil sciences and to achieve international recognition for our work. All of these aims will be enhanced through our interactions with our stakeholders via education, extension and outreach activities.
Unique Strengths of Plant and Soil Sciences (PLSC)

Our unique strengths that allow us to fulfill this vision are:

- A strong, integrated faculty with outstanding international reputations in (1) plant biology, (2) soil chemistry and environmental science, (3) landscape horticulture.
- A concentration of research on the interface between plants, microbes, and soils, and on the mechanisms which mediate their interactions.
- Remarkable breadth in our work that spans basic to applied research, and translates many of those findings to the field, while training students, stakeholders, and scientists.

The Future of PLSC – Our Vision for the Short and Long Term (25 years)

The current state of the PLSC undergraduate program and our majors is that we have had a relatively low number of undergraduate majors for many years, with our largest cohort in the Landscape Design & Horticulture programs. There are nearly as many graduate students in our department as undergraduate students. The low undergraduates-to-faculty ratio facilitates one-on-one interactions that are a hallmark of our department, although this would be negatively impacted if we were required to eliminate some of our low-enrollment courses. However, the number of undergraduates is too low, resulting in cancellation of some courses, and this number is below a level that may be sustainable. So while keeping these close interactions with the students, we would like to:

- See growth in the number of undergraduate majors to a healthier level, aiming for approximately 100 undergraduates in our department (versus 70 today).
- Teach exciting undergraduate and graduate level courses that are attractive to our majors as well as non-majors.
- Continue to provide a high level of mentoring and advising.
- Increase the credit-contact hours of our faculty.
- Increase the use of active learning processes in our courses.
- Enhance employment opportunities for the students via more internship and training opportunities.
- Improve our utilization of online teaching by offering a small number of additional, online courses to broaden our engagement with students and providing easier access to course materials.

The current state of the PLSC research program is that our department has had a steady increase in grant submissions, funding, and publications over the last five years. We seek to build on this success over the long term by reinforcing and building on this success through support of research-active faculty and the staff that contribute to this success. This research productivity depends on robust graduate programs, and thus there is some independency with the goal to build that program.

What We Will Leave Behind to Achieve the Above Goals

The primary thing that we anticipate leaving behind is the antiquated view of working in isolation within our department. Over many years, our department has been evolving towards multidisciplinary programs, evident in the numerous faculty members with joint appointments, cross-listed courses, and the cross-campus location of the facilities at which our faculty are located. Our teaching programs will benefit from reduced barriers across departments as we’ll be able to attract a broader range of students. Likewise, our research and graduate education programs will be greatly enhanced by projects and grants that span the university. All aspects of our departmental efforts will be enriched by greater engagement in our community and local or regional
businesses.

Beyond this, we are planning to make changes to our majors (described below) that will “leave behind” aspects of our current academic programs.

**Stakeholder Input**

The clearest group of stakeholders is our alumni, who have experienced our teaching and research programs, and then gone on to work at businesses, in the government, non-profits, academic or other institutions. We are currently awaiting the results of survey of stakeholders developed in conjunction with Tom Ilvento.

**Curricular Revision**

We have several proposed changes to our undergraduate majors, grouped into three major areas – the first two are our current majors, while the third is a proposed new major.

**Plant-related majors currently include the following:**

- *Plant Protection*. This major is shared with ENWC. Enrollment is 2 in 2012-13.

In the long-term, we envision consolidation of these majors into a smaller set of majors with concentrations, perhaps consolidating these majors across departments within the college to create interdepartmental majors.

We are also actively discussing the development of a Bachelor of Landscape Architecture (B.L.A.) degree program, which for accreditation purposes may need to be a stand-alone major. If this proves successful, it could serve to launch a Master of Landscape Architecture degree at some point in the future.

Thus, in the near term, our plan for the plant-related majors is to offer two majors, one focused on landscape design (retaining that successful program and its emphasis on design), and one that integrates soil and environmental science into our plant science major, with concentrations that focus on basic sciences in these areas.

The long-term target for undergraduate enrollment is to grow to more than 100 undergraduates within the next five to ten years, while keeping in mind that some of the students who would be interested in the current majors might end up in the Genetics & Genomics major described below.

**Another current major to reconfigure is Environmental Soil Science.**

The future of this major is an area of active discussion by the faculty, as the enrollment is just five students in 2012-13. The challenge is that we have a number of highly acclaimed faculty members, including many junior faculty members who are interested to grow the program, yet most of their work is in the larger “environmental” area which is largely occupied by other colleges at UD. The courses we offer in this area count towards the concentration in Environmental Soil Science, within the Environmental Science major, but none are part of the required core of classes for that major, or any of the other nine concentrations within that major.

As mentioned above, the option that the faculty have been discussing is consolidating the Environmental Soil Science, Plant Horticulture, and Landscape Design majors into a single major (as yet untitled). This new major would have a common core of classes required of all students plus three tracks for specialization, tentatively entitled: 1. Agricultural Sciences (agronomy), 2. Ecosystems Sciences (Soils, Ecology issues). 3. Plant Sciences/Biology. The Agricultural Sciences track would focus on producing graduates interested in agronomic education and crop management with a sustainability focus. The Ecosystem Science track would essentially replace the current Environmental Soil Science major and produce graduates interested...
in natural resource sciences and management, ecosystem restoration, environmental consulting, government scientific organizations, or may lead to enrollment in graduate school. And the Plant Biology concentration would focus on basic plant sciences including horticulture, plant propagation, molecular biology, etc. This proposed change would reduce the number of majors in the department, have a title that is more attractive to incoming students, and will provide courses, both existing and new, that will bring together the existing strengths among our faculty and increase university-wide enrollment in PLSC courses.

The long-term target for our Environmental Soil Science program is for growth, but this is likely to be achieved via integration with other majors, in the near term.

We propose a new major: Genetics & Genomics.

We envision the creation of an interdepartmental degree program that leverages the expertise of faculty across CANR that work in the area of genetics and genomics, a field with clear, long-term relevance to agriculture and natural resources management. Major objectives are to: [1] offer a contemporary degree program with expansive job opportunities for graduates; [2] provide more flexible degree options for students with multiple inlets and outlets; a key feature being a contiguous BS/MS program; [3] capitalize on common threads in research and extension activities among CANR faculty. Such a program would benefit a number of faculty members in our department, so it is to our benefit to develop and grow such a program.

The target for undergraduate enrollment in this new Genetics & Genomics program is to make this a large program, hopefully exceeding our other two large majors which currently have ~30 students each. In other words, we envision this program as an opportunity that could support significant growth.

The current state of the PLSC graduate program and our fields of study is that the total number of graduate students in our department is relatively strong, with nearly as many graduate students as undergraduates. This is because we have many faculty with well-funded research programs that support their students. Plus, the Longwood Graduate Program has independent funding for graduate students. However, because we have a single graduate program, our graduate students share few courses, and enrollment in some courses is weak, perhaps because we have almost no course requirements. Addressing this problem will require greater enrollment of our students across a broader range of our course offerings – a change that is currently underway as a result of the hiring of new faculty that are committed to making such a change.

Proposed changes to our graduate concentration areas:

Area of emphasis: Landscape Horticulture and Design

The Longwood Graduate Program (LGP) is highly successful, but enrollment is limited because for financial reasons and the time it takes the faculty adviser to successfully mentor a cohort of students. We anticipate little growth in the LGP program. Ultimately, however, growth in this area could come in large part from a master’s degree program in landscape architecture (M.L.A.) which would have a unique strength (relative to other MLA programs) due to our department’s strong expertise in plants and public gardens. The development of this program would depend on the successful development of the undergraduate BLA major discussed above.

We also would like to grow research programs in the area of horticulture, which could include breeding and development of ornamentals, fruits or vegetables; a faculty member with expertise in breeding of ornamentals would fit very well with the Genetics & Genomics program described elsewhere. And the new faculty position in Urban Forestry should be involved in growing this program in new directions that will support horticulture.

Area of emphasis: Plant Biology
The development of the new undergraduate major in Genetics & Genomics ("G&G") would provide excellent benefits for the graduate program in plant biology, which includes most of our faculty working in the area of molecular biology. We envision that the G&G program would include a number of large classes that would require teaching assistants (TAs). With these TAs, we could bring in a cohort of graduate students that could rotate among labs, comprising a more typical graduate program. In addition, the G&G program would offer a 4+1 program, whereby students could receive an M.S. degree with one additional year of school after their undergraduate degree. This would be a non-thesis, course-based offering, which would help to grow class sizes at the graduate level, and it would bring in graduate tuition. We would also like to require a set of core classes for these students, which could be taught as short modules, and could include practical methods courses - which would require a graduate teaching lab.

Areas of emphasis: Environmental Soil Sciences and Management

The merging and refocusing of the undergraduate Environmental Soil Science and Plant Horticulture, and Landscape Design majors into a single major entitled Sustainable Landscapes and Ecosystems with specialization tracks would have impacts on graduate students in the soil sciences. Because the new major would have a focus on ecosystems-scale science this would encourage development or enhancement of coursework focused on environmental systems. This emphasis would also highlight the ecosystem-sciences research areas of the faculty. Students are aware of the serious global environmental issues we face; thus, we foresee the undergraduate major driving a shift and an increase in the quality and size of the pool of graduate students applying to the graduate program, while maintaining our current strengths in Environmental Soil Sciences and Management. Other developments outside but affiliated with the department will enhance this perception. Examples include the new university-wide graduate program in Water Science & Policy; the Delaware Environmental Institute; the Delaware Water Resource Center; and the Interdisciplinary Science and Engineering building. It is hoped that the new undergraduate major will attract students to the department and the subsequent addition of TA positions beyond the one position affiliated with the Introduction to Soil Science course. Lastly, the department will encourage research-active soils and water faculty to offer their graduate students mentorship experience by hosting the best and brightest undergraduates in research experiences within their laboratories. Increasingly, employers are looking for the ‘above & beyond’ coursework experiences that research internships can provide to undergraduates. We believe that such opportunities are a ‘win-win’ for the undergraduate intern, the graduate student, and the hosting faculty member.

Staffing Plan

To accomplish our goals in the area of undergraduate curriculum, we will need to:

• Support our landscape design and ultimately BLA program via hiring of faculty and instructors to help grow the program.
• TA lines to assist with anticipated larger class sizes.
• Teaching lab manager, if we’re going to develop labs for these classes.
• Hire a recruiter for department (perhaps a recent graduate; not necessarily full time).

To accomplish our goals in the area of graduate curriculum, we will need to:

• Development of the position of a graduate coordinator into a more clearly defined and recognized administrative, mentoring, and advising position could benefit our research-oriented graduate programs (plant biology and environmental soil sciences).
To accomplish our goals in the area of growth in research we will need to strengthen and retain our faculty. The department has significant strengths in both soil chemistry and plant biology. In both cases, these should be maintained and strengthened with additional hiring in complementary areas. Success in graduate education programs will also contribute to the attainment of this goal, through improvements to both recruitment and retention of faculty. In addition, we will need continual enhancements to grant administration, as the importance of administrative staff cannot be overstated. The submission of proposals and financial/administrative accounting of existing awards can be challenging, particularly for researchers who are often more focused on their academic questions that are the reason grants are awards are made. Thus we should hire, train, promote and reward the staff that can facilitate these processes.

**Space Utilization Plan and Facility Needs**

To accomplish our goals in the area of undergraduate curriculum, we will need to:

- Dramatically improve and modernize our teaching space to provide classrooms and teaching labs for cutting-edge educational opportunities. In the context of the Genetics and Genomics major, this would require substantial updates and new equipment, as well as computer labs for bioinformatics work in the classes.
- Upgrade teaching facilities (the greenhouse rooms) with modern IT equipment and create better spaces for learning (problem-based learning environments).

To accomplish our goals in the area of graduate curriculum, we will need to:

- Offices for the expanded graduate student enrollment that we envision.
- A graduate teaching lab for methods-based courses in plant molecular biology.
- Improved, modernized laboratory space that will put students in different labs in close proximity, and will include desks in the lab or very close to the labs for graduate students will facilitate their work and help with recruiting.
- In the longer term, we will need to invest to improve and maintain the quality of our greenhouses, and growth chambers and field spaces to facilitate teaching of plant courses and the research performed by our graduate students, particularly if we are to strengthen horticulture, soils, and plant biology as we would like.
- Workshop facilities - Faculty need access to workshop facilities where faculty and students can fabricate and assemble instrumentation for field studies. This is a major need for plant, soil and water faculty who have programs that extend beyond the traditional laboratory. Such space is currently available in the college in our farmhouse facilities.

To accomplish our goals to enhance our research productivity, a high priority is improved research facilities. High-grade research facilities contribute in innumerable ways, including recruitment and retention of faculty, staff and graduate students, including facilitating high quality research and interactions among researchers, providing safe working conditions, providing flexibility in research activities as technologies develop and change. Given the poor state of Worrilow Hall, our department has taken a piecemeal approach of making the best of this low-grade facility, and seeking better space as it became available (e.g. DBI & ISE, and it was hoped, the Girl Scout Building). Unfortunately, faculty that remain in Worrilow Hall have research space that is of poor quality, which may affect the quality of research from these labs. This has and will result in a department that is increasingly fragmented, with faculty that don’t well understand their colleagues’ research programs, don’t know their lab members, etc. The worst case scenario is that in their absence, faculty become alienated from the department. The best remedy is to bring faculty back together, but some are reluctant to give up the interdisciplinary space that they have come to appreciate (like at DBI). Thus, this should be retained by
developing space that reunites PLSC faculty while pulling in colleagues from other departments and colleges – putting everyone closer together.

Thus we can envision the following steps to improve our research programs:

- Consolidation of PLSC faculty laboratories in one, modern, research building to mitigate the increasing decentralization that has occurred in pursuit of top-tier research space and to accommodate the space required for new hires in the department, particularly for laboratory space and post-doc/student office space which is currently not sufficient for existing faculty.
- Work together with other departments and colleges to ensure that this is also interdisciplinary space, thus replicating the strengths of DBI & ISE facilities.
- Maintenance and expansion of plant growth facilities. Our growth chambers and greenhouses are adequate at the moment, but may require expansion depending on the needs and productivity of our faculty.
- Workshop facilities - Faculty need access to workshop facilities where faculty and students can fabricate and assemble instrumentation for field monitoring. This is a major need for soil and water faculty who have monitoring programs that extend beyond the traditional laboratory. Such space is currently available in the college in our farmhouse facilities (currently under Bioresources Engineering).

**Needs in Terms of Services from Support Units**

To accomplish our goals in the area of undergraduate curriculum, we will need to:

- Improve our IT technology for teaching genomics, bioinformatics, and distance learning, including improved desktop and laptop computers in faculty offices.
- Provide incentives for developing and teaching “recruiting courses.”

To accomplish our goals in the area of graduate curriculum, we will need to:

- Vehicles/trucks for field sampling; workshop needs. Many of our research and extension faculty have field activities where faculty and students have to routinely collect samples from field sites near and far from the UD campus. While the department has two trucks (one just recently acquired from Bioresources Engineering) these vehicles are limited and not in the best of conditions. Future resources need to be allocated to purchase/provide new or used vehicles to faculty.

**Areas or Initiatives**

As described above in the “Curricular Revisions” section, we believe that we have three particular strengths that represent areas in which we should continue to build on our past success. This includes plant molecular genetics & genomics, environmental soil science, and landscape design. We have had tremendous success in hiring in these areas for a sustained period of time, and this has led to significant strengths in these areas that should be maintained.

**Foundational Steps, Action Items Planned**

To address our aim of improving our undergraduate curriculum, we have several strategies:

- Recruit a larger number of incoming students into our programs.
- Make our programs and courses relevant and interesting to a greater number of students.
• Promote our majors, career opportunities, and courses to students.
• Promote the availability of research or internship opportunities for our best undergraduates.
• Promote our students and graduates for industry and government jobs.
• Consider online teaching methods for their utility and impact.

Thus, our activities to accomplish our goals in the area of undergraduate curriculum development include:
• Select titles for our majors and courses that reflect their content and offer options more attractive options to incoming students.
• Better advertise our majors and course offerings to prospective and current students.
• Teach more “recruiting” courses that engage undeclared students or students from other majors in exciting topics within plant and soil sciences. (i.e. a Farm-to-Table course that includes growing organically, popular foods, food preparation and presentation; Sustainable Landscaping course that includes rationale for sustainability and methods for incorporating sustainable concepts such as rain gardens, green roofs, meadows, reforestation, native plants in residential and public landscapes, etc.)
• Evaluate all current courses and eliminate or revamp those that no longer meet our goals.
• Provide research, training, and internship opportunities to our students.
• Implement an active learning pedagogy in more of our classes.

To address our aim of improving our graduate curriculum, we have several strategies:
• Increase participation in interdisciplinary graduate programs.
• Expand opportunities for training scientific staff/workforce for industry, non-profit and academia.
• Build a graduate component to the proposed Genetics & Genomics program that would include development of a 4+1 B.A.-M.S. program
• Expand teaching opportunities for graduate students, in part via TAing of the Genetics & Genomics courses.
• Increase graduate funding through training grants.
• Increase graduate enrollment in the Soils program through recruitment from our new undergraduate major.

Thus, our activities to accomplish our goals in the area of graduate curriculum development include:
• Identify and/or develop core classes for each of the emphasis areas in our graduate program.
• Increase graduate student participation in our own grad-level courses.
• We could potentially partner with other institutions, domestically or internationally, to develop these programs, co-teach courses via remote connections to expand our offerings and having larger groups of students.

To address our aim of improving our research programs, we have several strategies:
• Reunite research-focused faculty and their laboratories in one, modern, research building, while maintaining the interdisciplinary strengths of DBI & ISE facilities.
• Closely integrate extension staff and faculty into research.
• Hire in complementary areas to build on existing strengths.
• Work with our neighboring institutions to coordinate research, minimize overlap or duplication, and support common goals.
• Encourage faculty to pursue extramural funding from new and non-traditional sources including international groups, industry, commodity groups or foundations, private investors, and
philanthropic organizations.

Thus, our activities to accomplish our goals to strengthen and grow our research programs include:

- Support and strengthen research programs of current faculty to retain the excellent research programs that are expensive and difficult to build.
- Strategic hiring to complement existing strengths in plant biology, plant-microbe interactions, environmental soil science, soil chemistry, and water science.

**Appendix (Stakeholder Survey Results)**

The stakeholder survey is currently underway, led by Tom Ilvento. We anticipate this will be completed during winter of 2014.