Date: September 6, 2016

To: Academic Affairs

From: Frank Galey, Dean, College of Agriculture and Natural Resources

Re: Soils MS Graduate Program Review

I would recommend this program be retained at the University of Wyoming with the following comments.

- This program is near the minimum cut-off of 15 graduates over a 5 year period at 12.
- Soils is a key driver in an important part of UW's mission to the state as it directly supports the reclamation ecology center.
- Graduates of this program are quickly placed in industry or government (mostly NRCS) and we have wide support for our students. This program also is a good feeder for the PhD program which is also important to our reclamation, range, and soils programs.
- A strong soils group is important to our land-grant mission of serving our constituents in production agriculture as well.
- This program has had a large amount of turnover in the past few years with retirements, etc. Thus, I expect the program to grow to higher productivity levels.
- Many of the soil science faculty are engaged in field work in response to energy industry and producer needs either via the experiment station or the extension service. Thus, the actual instructional FTE devoted to their BS, MS, and PhD programs is reasonable. In addition, the faculty have been adept at attracting funding for their research activities.
- This department is encouraged to continue to explore the use of the MS program as a pipeline to their PhD program. In addition, the department is encouraged to look for efficiencies in offering all of its MS programs, perhaps through creating options within the overall MS as one suggestion.

Thank you and please let me know if you wish to discuss this further.

Academic Program Review

Title of Program:	MS Soil Science
Undergraduate of Graduate program:	Graduate
Department:	Ecosystem Science and Management (ESM)
College:	Agriculture and Natural Resources (ANR)
Department head:	Scott Miller, snmiller@uwyo.edu, 766-4274

1. Program Demand

Soil science is a discipline rooted in agricultural science. Over the past decades, soil science has expanded and become a partner in the ecological, environmental, hydrological, and climate sciences. Soils are an important part of the earth system which is increasingly being recognized through research initiatives such as the NSF-funded critical zone observatories.

Soil science faculty in the ESM department teach SOIL, REWM, MOLB, and AECL courses that contribute to the curriculum of the department, the college of ANR, and UW. There is no undergraduate degree in soil science at UW. Instead soils faculty manage the soil minor, MS Soil Science, and PhD Soil Science degrees.

The current academic program review only concerns the MS Soil Science degree. Enrollment and graduation numbers are summarized in the table below. Numbers are given for the past five academic years. Further details on number of graduates and enrollment can be found in Appendix A

Table: MS Soil Science degree enrollment and graduation numbers for the September 2011 – August 2016 evaluation period.

Academic year	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	average
Enrollment	9	8	6	7	11	8.2
Graduated	4	3	1	3	1	2.4

The number of MS Soil Science graduates over the September 2011 to August 2016 evaluation period was 12 (average of 2.4 per year). The average enrollment in the MS Soil Science degree during any year of the evaluation period was 8.2. It should be noted that soils faculty also enrolled and graduated a sizeable number of students in other MS degree programs. These students are summarized separately in the table below (see Appendix A for details).

Table: Enrollment and graduation numbers for other MS students (not Soil Science) with soils faculty as the major advisor (September 2011 – August 2016 evaluation period).

Academic year	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016	average
Enrollment	8	9	6	4	4	6.2
Graduated	2	3	2	1	1	1.8

When taken together, the total number of MS graduates (Soil Science and Non-Soil Science) with soils faculty as the major advisor becomes 21 over the 5-year evaluation period (average of 4.2 per year) and the average enrollment during any year becomes 14.4. This exceeds the "low demand" designation for an MS program of 3 graduations per year for a total of 15 students per 5-year period. Note that the above numbers only relate to MS students. No PhD students are included in the above numbers.

2. Program Quality

a. Program accreditation

We are unaware of any organization that accredits soil science degree programs. The Soil Science Society of America does have a program to certify individual soil scientists. Certification requires a bachelor degree with 15 credit hours in soil course work, the successful completion of a "Fundamentals of Soil Science and Professional Practice" exam, and 5 years of post BS or 3 years of post MS/PhD experience.

An academic program review of the MS and PhD soil science degrees was conducted in 2010. The review stated that the soil degree programs were successful and of good quality, that demand for soil graduates was high, and that the degree programs should be continued. Average enrollment was 11 MS students and 5 PhD students during any year of the 2000-2010 evaluation period. The columnar nature of the major soil disciplines (i.e. classification, physics, chemistry, microbiology, fertility) was perceived as both a strength and a weakness. A strength because having specialists in each discipline ensures rigorous courses. A weakness because few soils faculty are comfortable teaching outside their direct area of expertise.

Over the past six years the soils faculty has significantly transformed with the retirement of three senior professors and the subsequent recruitment and hiring of three assistant professors. The research and graduate support from soils faculty declined in the years prior to the retirement of the professors, and we have already seen a large uptick in graduate student hiring in the past two years. In 2010 the biggest threat to the MS and PhD programs in Soil was the impending retirement of three out of six soil science faculty. Since that time, Drs. Williams, Munn, and Vance retried, and Drs. Zhu, Vaughan, and van Diepen have been hired. As a result, the soils faculty are in a good position to support the soil minor, MS Soil Science, and PhD Soil Science degree programs into the future. One gap in the soils program that was identified in the 2010 report, and that has not been filled, is the lack of a soil and water conservation expert.

b. Credentials of faculty

Current soils faculty are (with starting year in parentheses):
-Peter Stahl, Professor, Soil Ecology, Director Wyoming Restoration and Reclamation Cr (1995)
-Jay Norton, Associate Professor, Extension Soil Fertility Specialist (2006)
-Thijs Kelleners, Associate Professor, Soil Physics (2006)
-Mengqiang (Mike) Zhu, Assistant Professor, Soil and Environmental Biogeochemistry (2013)
-Karen Vaughan, Assistant Professor, Pedology (2015)
-Linda van Diepen, Assistant Professor, Soil Microbial Ecology (2015)

The job descriptions for the current faculty are given in the table below:

Table: Soils faculty job descriptions (from *before* the summer 2016 updates)

Name	Teaching %	Research %	Extension %	Service %	Administration %
Stahl	25	42	0	8	25
Norton	0	40	50	10	0
Kelleners	45	50	0	5	0
Zhu	45	45	0	10	0
Vaughan	45	45	0	10	0
van Diepen	45	45	0	10	0

This translates into a teaching FTE of 2.05 and a research FTE of 2.67. Of the current faculty, Stahl, Norton, and Kelleners are white males, Zhu is an Asian male, and Vaughan and van Diepen are white females. Retired soils faculty that were active during the past 5 years include (with retirement year in parentheses):

-George Vance, Emeritus Professor, Soil Chemistry (2012)
-Stephen Williams, Emeritus Professor, Soil Biology (2013)
-Larry Munn, Emeritus Professor, Pedology (2014)

Details about grants awarded (~$3.7M) and refereed journal publications (~80) for the current soils faculty for the Sep. 2011 – Aug. 2016 evaluation period are given in Appendix B and C, respectively. National/international awards and service to professional organizations for the current soils faculty are given in Appendix D and E, respectively. Additional information is available upon request.

c. Program reputation

We are unaware of any organization that ranks soil science degree programs. Our graduates are in high demand and have found employment in academia, government agencies, and private industry. Personal communication with Wyoming Natural Resources Conservation Service (NRCS) personnel (Astrid Martinez, State Conservationist) and Reclamation industry personnel (Brenda Schladweiler, President and Principal Scientist BKS Environmental, Gillette, WY) indicates that graduates from the MS Soil Science degree program remain popular with employers.

d. Curriculum

The following soils courses are currently being offered by the soils faculty:

-SOIL 2010 Introduction to Soil Science (Spring, 4 credits, Vaughan)
-SOIL 3130 Soils and Environmental Quality (Fall, 3 credits, Zhu)
-SOIL 4100/5100 Soil Physics (Spring, 3 credits, Kelleners)
-SOIL 4105/5105 Soil Physics Laboratory (Spring, 2 credits, Kelleners)

-SOIL 4120/5120 Genesis, Morphology, and classification of soils (Fall, 4 credits, Vaughan)
-SOIL 4130/5130 Chemistry of the Soil Environment (Spring, 3 credits, Zhu)
-SOIL 4140/5140 Soil Microbiology (Spring, 4 credits, van Diepen)
-SOIL 4150/5150 Forest and Range Soils (Fall, 3 credits, van Diepen)
-SOIL 4160/5160 Soil Fertility and Fertilizers (Fall, 3 credits, Norton)
-SOIL 4590/5590 Special Topics: Soil Mineralogy (Fall, 3 credits, Zhu)
-SOIL 5110 Modeling Flow and Transport (Fall, 4 credits, Kelleners)

Other courses currently taught by the soils faculty:

-REWM 4200 Reclamation of disturbed land (Fall, 3 credits, Stahl)
-MOLB 4540/5540 Microbial diversity and ecology (Fall, 4 credits, van Diepen)
-AECL 4990 Agroecology capstone (Spring, 1.5 of 3 credits, Kelleners)

e. Distance delivery

No courses are offered online and/or off-campus. Stahl and Norton do deliver off-campus reclamation workshops through the Wyoming Restoration and Reclamation Center.

f. Quality of assessment plan/data

There is currently no dedicated assessment plan or assessment data collection. The quality of the MS Soil Science degree is primarily safeguarded through the final defense seminar and the committee defense. For a few years we offered a special course entitled “Soil exam” that prepared students for the Soil Science Society of America Soil Science Fundamentals Examination. The success rate in taking the actual exam would be a good indicator of program quality. Unfortunately, the soil exam course was discontinued because or time constraints and the retirement of the leading faculty (Vance). With the soils faculty back up to strength, we may decide to restart the soil exam course. The new pedologist (Vaughan) has restarted the Wyoming soil judging team, in which undergraduate students compete nationally in soil classification. This provides another opportunity to assess the quality of the soils program.

The ESM Department conducts a graduate student assessment that consists of four parts, and Soil Science MS students are included in this assessment:

1. Informal review. Faculty are engaged in ongoing dialogue with the head and as a unit to ensure that adequate and appropriate courses are being taught and that students are receiving appropriate mentoring.
2. Annual student evaluation. The students are reviewed annually by their major advisor using a rubric provided by the department. Continuation of funding and graduate school is contingent on adequate progress.
3. Committee review. At the conclusion of the students’ MS, each member of the graduate committee fills in a rubric that evaluates the student based on a range of metrics including (a) knowledge content; (b) communication ability; (c) professionalism / readiness; (d) intellectual contributions
4. Student review. At the conclusion of the student’s program the student is asked to meet with the department head for an exit interview, at which point the student provides

feedback regarding his/her experience, workplace readiness, job prospects, overall satisfaction with the UW experience, and more.

g. Strategic plan

The college of ANR strategic plan (academic plan 4 – draft – May, 2014) lists a number of significant issues that relate to soils. These are: Environment, agriculture, water quality and availability, and reclamation of disturbed lands and waters.

The strategic plan contains no facility upgrades for soil research. Our current facilities are adequate at present, mainly because of a culture of sharing resources. Laboratory spaces are assigned to individual faculty, but students are generally allowed to work in any soil laboratory. Laboratory space for the soils group may become limiting in the future as the three assistant professors (Zhu, Vaughan, van Diepen) continue to build their programs. Hands-on learning is stressed in the college of ANR plan and several of our soils courses have a practical component. Our introductory soils course (Vaughan) benefits from having laboratory teaching space in the new STEM building.

The college of ANR strategic plan expresses the desire to build the Wyoming Reclamation and Restoration Center (WRRC) into the largest and most respected program of its kind in the world. The center is currently directed by one soils faculty (Stahl) with major research contributions from another (Norton). The strategic plan also expresses intent to hire a faculty member in the area of disturbed soils remediation. This would open the possibility of increasing our course offerings in the area of reclamation and restoration.

Finally, the college strategic plan calls for increased service and engagement with stakeholders in the state with emphasis on, amongst others, sustainable agricultural systems and range and reclamation resource management. Use of the four agricultural experiment stations at Powell, Sheridan, Lingle, and Laramie is encouraged. One soils faculty (Norton) is especially active in this regard, through his extension program on soil fertility, and by conducting field experiments at the Powell and Lingle stations. A significant amount of field work at these stations in conducted by MS Soil Science students.

3. Mission Centrality

a. Contribution to the mission, vision, and strategic goals of UW

The UW strategic plan (academic plan 4, 2015-2020, draft, Oct. 2014) lists education, research, and service in the fields of Environment, Agriculture, and Natural Resources as an area of distinction. Soils being at the interface of the atmosphere and lithosphere, as well as being in the biosphere, are a critical part of all three fields. So much so that the science community has adopted the term critical zone for the region between the top of the canopy down to the groundwater level that includes soils.

Natural Resource extraction is the main economic driver of Wyoming's economy. UW's strategic plan calls for increased support for academic programs that enhance the state's economic competitiveness. Soil science contributes to improved practices in the extraction industry mainly by developing and testing more effective reclamation and restoration techniques that are essential to meet state and federal regulations.

Finally, the academic plan calls for the promotion of interdisciplinary science to deal with complex issues. Water availability, sustainable food production, and climate change are some of the most complex issues facing humanity. Knowledge about the physical, chemical, and biological processes in soils and the spatial distribution of soils is essential when working towards solutions of these complex issues.

b. Contribution to other programs across campus

Many soil courses are cross-listed undergraduate/graduate. Undergraduate degree programs that benefit from the soils program are Agroecology, Rangeland Ecology and Watershed Management, and Earth System Science, amongst others. Graduate degree programs that benefit are Agronomy, Rangeland Ecology and Watershed Management, Hydrologic Science, Botany, Ecology, Geology, and Civil Engineering, amongst others. The wide array of programs that benefit from the soils program is a reflection of the interdisciplinary nature of soil science.

c. Placement of graduates

The table below shows the current employment status of the Soils, REWM, Anthropology, Civil Engineering, and Environmental Engineering graduates for which soils faculty were the major advisor.

Table: Current employment status for MS students (Soil Science and Non-Soil Science) with soils faculty as the major advisor. Sorted by graduation date. Some students were co-chaired (see Appendix A).

Student	MS Program	Graduation Date	Advisor	Current Employer
Xuan He	Soils	Dec, 2011	Vance	Graduate studies in Japan
Cally Driessen	Soils	May, 2012	Norton	KC Harvey Environmental LLC
Lisa Cox	Soils	May, 2012	Stahl	Substitute UW lecturer / Laramie vegetable farm
Kyle Lilly	Soils	May, 2012	Vance	Specialty crop company, MN
Joel Mason	REWM	May, 2012	Stahl	Apex Environmental, Laramie, WY
Brigid Grund	Anthro	Aug, 2012	Williams	UW PhD student
Jennifer Faulkner	Soils	Dec, 2012	Norton	Intertech Inc., Rock Springs / Lander vegetable farm
Ge Zhu	Soils	Dec, 2012	Williams	Technician, Univ. of Arizona
Alix Hakala	Soils	Dec, 2012	Vance	Environmental Services, Glenrock, WY
Hillary Jones	REWM	Dec, 2012	Stahl	Trout Unlimited
Zachary Liesenfeld	REWM	May, 2013	Stahl	BCP Energy, Greeley, CO
Leah Birgen	Envir. Eng.	Aug, 2013	Vance	Unknown
Rachana Giri	Soils	May, 2014	Stahl	Seattle, caring for infant
Claire Wilkin	Civil Eng.	May, 2014	Williams	Environmental consulting, San Francisco, CA
Michael Curran	REWM	May, 2014	Stahl	UW PhD student

Samantha Day	Soils	Nov, 2014	Norton	Fullbright travel scholarship, Nepal
Erin Bast	Soils	May, 2015	Norton	UW PhD student
Erin Barnholt	REWM	May, 2015	Stahl	The Nature Conservancy
Seth Cude	Soils	Aug, 2015	Norton	RESPEC, Lexington, KY
David Balthrop	REWM	Jun, 2016	Stahl	Environmental consulting, Ft Collins, CO
Benjamin Wolff	Soils	Jul, 2016	Stahl	Systems analyst, WY State Gov.

d. Program importance for UW

Soil science is a key discipline at most land grant universities. Initially soils science was part of the general field of agronomy. Nowadays soil science informs, and is informed by, the agricultural, ecological, environmental, hydrologic, and climate sciences. Within UW, soil science is consolidated within the ESM Department soil group. This is especially true since two "soils-minded" professors in the Botany Department (Elise Pendall and Indy Burke) have recently left for other universities. Soils knowledge in other UW departments (i.e. Jianting Zhu and Fred Ogden in Civil Engineering and Cliff Riebe, Andrew Parsekian, and Ye Zhang in Geology & Geophysics) mainly relates to hydrology and geology, and is mostly complementary. In fact, there are several fruitful ongoing collaborations between the soils group and Civil Engineering and Geology & Geophysics faculty, mainly through the Wyoming Center for Environmental Hydrology and Geophysics (WyCEHG). Additional collaborations of the soils faculty include a new proposed Long Term Ecological Research (LTER) site in Wyoming and a new EPSCoR track-1 proposal (with the Botany, Zoology & Physiology, and Geology & Geophysics Departments).

4. Cost

a. Ratio of student credit hours per FTE

The average number of student credit hours per FTE per year over the past five academic years was:

-Undergraduate teaching	625.1/2.05	= 304.9
-Graduate teaching	194.9/2.05	= 95.1

Where 625.1 and 194.9 are the total student credit hours per year (Appendix F). Only the SOIL courses are considered. The calculation uses teaching FTE = 2.05, based on the teaching appointments of the current soils faculty. It should be noted that three soils faculty retired during the past 5 years, resulting in interruptions in the course offerings.

b. Direct instructional expenditures

Direct expenses allocated for instruction and advising to soils faculty in 2015 were $7,800, which is similar to amounts set aside in previous years. These expenses were allocated to support all levels of instruction, including undergraduate, MS and PhD.

Faculty allocations per FTE are calculated as:

$7,800 / 2.05 = $3,805 / teaching FTE

Faculty allocations per SCH are calculated as:

$7,800 / 819.2 = $9.52 / SCH

Instructional expenditures due to faculty salaries are listed below. Faculty salaries FTE for teaching are not dedicated to MS support alone, of course, so the data paint a poor portrait of the financial impact of supporting the MS program.

- Expenditures are based on the current composition of the soils faculty (teaching FTE = 2.05
- Salaries of $106,800 for full professors, $76,300 for associate professors, and $67,500 for assistant professors are used (which includes benefits)

This results in an instructional expenditure of $152,160 per year. The expenditures per student credit hour related to 2015 salaries are:

-Undergraduate teaching	$152,160/625.1	= $243
-Graduate teaching	$152,160/194.9	= $781

Where 625.1 and 194.9 are the total student credit hours per year (Appendix F).

The instructional expenditures per MS graduate degree awarded (soils and non-soils) are:

$152,160/4.2 = $36,229

Where 4.2 is the average number of MS soils and non-soils graduates per year over the past five years with soils faculty as the major advisor.

c. Course enrollment

Minimum course enrollment for an undergraduate course is 10 while the minimum enrollment for a graduate course is 5. The soils group teaches many combined undergraduate/graduate courses (i.e. 4000/5000). For these courses the minimum enrollment is either 10 undergraduate OR 5 graduate students. From the information in Appendix F we can see that the following courses were under-enrolled during the past 5 academic years:

SOIL 4105/5105 Soil Physics Laboratory	year 12/13
SOIL 4130/5130 Chemistry of the Soil Environment	years 14/15 and 15/16
SOIL 4150/5150 Forest and Range Soils	years 11/12, 13/14, 14/15, and 15/16

Of these SOIL 4150/5150 was taught by graduate students and temporary hires for several years after the retirement of the responsible faculty (Williams). This course will have a new teacher (van Diepen) in the coming year.

d. Other instructional cost drivers

The soil teaching program has been challenged by three retirements during the past five years. Two regular courses (SOIL 3130 and SOIL 4130/5130) were not taught during the 2012/2013 academic year because of the retirement of the soil chemist (Vance). Other courses were taught by other soils faculty (e.g. SOIL 4120/5120 by Norton in the 2014/2015 academic year), while some courses were taught by graduate students or temporary contract hires (e.g. SOIL 4150/5150). Currently, with all three retirements replaced, all soils courses are again taught by soils faculty and no funds are used for contract hires.

e. Research expenditures per tenured/tenure-track FTE

The research portion of the current soils faculty job descriptions translates into a research expenditure of $204,651 per year (faculty salary × % research /100)

Research money from funded projects (Appendix B) totals to $3,726,964 over 5 years or $745,393 per year. This number is almost certainly an overestimate since multiple investigators are involved in most funded project, and funds are not always broken down to individual PIs and co-PIs.

f. Comparison to national benchmarks

The table below shows a comparison between selected teaching indicator values for the soils faculty as compared to the entire ESM Department faculty, which includes the soils group.

Table: Comparison between soils group and ESM Department indicator values

Indicator	Soils group	ESM Department
Number of faculty	6	20
MS students enrolled (students / year)	14.4[a]	42.4
MS students graduated (students / year)	4.2[a]	12.6
Undergraduate student credit hours (per year)	625.1	3,314
Graduate student credit hours (per year)	194.9	1,017

[a] Soils and non-soils with soils faculty as the major advisor.

APPENDIX A: MS Enrollment and graduates

MS Soil Science students over 5-year period (Sep 2011 – Aug 2016). Graduation date is given for students that graduated.

Student	Start date (month, year)	Graduation date (month, year)	Major Advisor
Ge Zhu	Sep, 2008	Dec, 2012	Williams
Cally Driessen	Jan, 2009	May, 2012	Norton
Lisa Cox	Jan, 2009	May, 2012	Stahl
Xuan He	Sep, 2009	Dec, 2011	Vance
Kyle Lilly	Sep, 2009	May, 2012	Vance
Jennifer Faulkner	Sep, 2009	Dec, 2012	Norton
Alix Hakala	Sep, 2009	Dec, 2012	Vance
Benjamin Wolff	Sep, 2009	Jul, 2016	Stahl
Robert Drapeau	Sep, 2011	-	Kelleners
Rachana Giri	Sep, 2012	May, 2014	Stahl
Samantha Day	Sep, 2012	Nov, 2014	Norton
Erin Bast	Sep, 2012	May, 2015	Norton
Seth Cude	Sep, 2013	Aug, 2015	Norton
Matt Covalt	Jun, 2015	-	Kelleners
Erin Rooney	Jun, 2015	-	Norton
Mark Pleasants	Sep, 2015	-	Kelleners
Amy Jacobs	Sep, 2015	-	Stahl
Mike Kasten	Jun, 2016	-	Norton/Vaughan
Zoe Ash-Kropf	Jul, 2016	-	van Diepen/Vaughan
Amanda Pennino	Aug, 2016	-	Vaughan
Matt King	Aug, 2016	-	Vaughan
Emily Bean	Aug, 2016	-	van Diepen

Other MS students (not Soil Science) over 5-year period (Sep 2011 – Aug 2016) with soils faculty as the major advisor. Graduation date is given for students that graduated

Student	Start date (month, year)	Graduation date (month, year)	Major advisor	Program
Joel Mason	Sep, 2006	May, 2012	Stahl	REWM
Erin Barnholt	Sep, 2008	May, 2015	Stahl	REWM
Brigid Grund	Sep, 2010	Aug, 2012	Williams (co-chair)	Antho.
Hillary Jones	Sep, 2010	Dec, 2012	Stahl	REWM
Zachary Liesenfeld	Sep, 2010	May, 2013	Stahl	REWM
Michael Curran	Sep, 2010	May, 2014	Stahl	REWM
Leah Birgen	Jan, 2011	Aug, 2013	Vance (co-chair)	Envir. Eng.
Claire Wilkin	Sep, 2011	May, 2014	Williams (co-chair)	Civil Eng.
Dylan Bergman	Aug, 2012	-	Stahl	REWM
Tyrell Perry	Aug, 2012	-	Stahl	REWM
David Balthrop	Jan, 2013	Jun, 2016	Stahl	REWM
Gordon Custer	Aug, 2015	-	van Diepen (co-chair)	Agronomy

APPENDIX B: Grants awarded to current soils faculty (Sep. 2011 – Aug. 2016)

Stahl:

Use of Coal Residues as Soil Amendments. P.D. Stahl, R.H. Coupal, A.M. Islam, J.F. McLaughlin, J.B. Norton. Funded by the Carbon Engineering Initiative, School of Energy Resources, University of Wyoming, $250,000. 2016-2018.

Disturbance and Reclamation Tracking. N.E. Graf, M.F. Curran, P.D. Stahl. Funded by the Wyoming Wildlife and Natural Resource Trust, $70,000. 2016-2018.

Funding of the Wyoming Reclamation and Restoration Center. F.D. Galey, P.D. Stahl, R.H. Coupal, S.E. Williams. Funded by Wyoming Department of Environmental Quality, $500,000. 2009-2012.

Energy development and wildlife habitat database organization. P. D. Stahl and J. Tanaka. Funded by Wyoming Department of Game and Fish, $20,000. 2010-2011.

Soil Biota on Post Mining Sites in USA and Europe. J. Frouz, K. Tajovsky, V. Kristufek, P.D. Stahl. Funded by KONTAKt, Czech Ministry of Education, 2008-2012.

Economic and environmental sustainability of conventional, reduced-input, and organic approaches on western crop-range-livestock farms. J. B. Norton, E.J. Arnould, G.D. Franc, B.W. Hess, J.P. Hewlett, T.J. Kelleners, A.R. Kniss, J.M. Krall, A.V. Latchininsky, D.E. Mount, V.B. Paige, S. Paisley, M.D. Press, D.E. Peck, B. Rashford, R.D. Smith, P.D. Stahl, N.L. Ward, and D.W. Wilson. Funded by USDA-NRI, Agricultural Prosperity for Small and Medium Sized Farms Program, $500,000, 2009-2012.

Improving sagebrush reclamation in bentonite mining areas of the Bighorn Basin. Proposal to implement a two-year investigation of past sagebrush reclamation successes and failures. P.D. Stahl and L. King. Funded by the Bureau of Land Management, $98,600. 2010-2011.

Norton:

2016-19 PI: Sustainable Production Practices for Edible Dry Beans. Wyoming Department of Agriculture Specialty Crop Program, $24,500.

2016-17 PI: Land Use, Landscape, Legacy Pollution, and Soil Health in Southwestern Poland. UW College of Ag & Natural Resources Global Perspectives Program, $4000.

2016-17 PI: Harnessing the Sun to Produce Fertilizer On-farm with Cyano Bacteria. Wyoming Department of Agriculture Specialty Crop Program, $24,500.

2015-18 PI: Developing an Inventory and Monitoring Framework of Herbaceous Riparian Wetlands in the National Trails Management Corridor of the Upper Sweetwater River Basin, Wyoming. USDI BLM $50,000.

2015-17 Co-PI: Best Cover Crop and Tillage Management Strategies for Dryland Winter-Wheat Cropping Systems in Northern High Plains. Co-PI on Wyoming Department of Agricutlure Ag Producer Priority grant program and UWAES, $40,000. PI: U.Norton.

2015-16 Co-PI: Mechanisms linking ecosystem N processing and hydrological transport following bark beetle-caused forest mortality. EPSCoR Seed Grant, $33,200. PI: U.Norton.
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2014-18 Co-PI: Compost carryover and cover crop effects on soil quality, profitability, and cultivar selection in organic dryland wheat. USDA-OREI in collaboration with Utah State, $1,555,000 total; $305,000 UW subaward (UW PI).

2014-16 PI: Soil Organic Matter, Water Use, and Crop Response to N and P in Sugarbeet-Bean-Barley Rotations under Conservation Tillage, Cover Crops, and Limited Irrigation. UW Ag Exp. Station Competitive Grant Program, $75,000.

2014-16 PI: Soil Health, Water Use, and Fertilizer Recommendations for Sugarbeet-Dry Bean-Barley Rotations under Conservation Tillage and Limited Irrigation, Wyoming Dept of Agriculture Ag Producer Priority Grant Program, and UW AES, $40,000.

2014-15 PI: Ecosystem Science Research, Education, and Capacity Building for Students and Scholars from Kenya and Wyoming. UW Global Perspectives Grant Program, $4000.

2013-15 PI: Soil Microcapillary Barriers for Improved Reclamation. Wyoming Reclamation & Restoration Center Graduate Assistantship Award and USDI-BLM, $40,000.

2012-14 PI: Amending Soils for Successful Reclamation: Effects of Gypsum, Compost, Cover Crops, and Other Amendments on Soil Physical and Biological Properties, UW School of Energy Resources and WRRC Graduate Assistantship programs, $60,000.

2011-13 Co-PI: Using Cover Crop Mixtures to Improve Soil Health in Low Rainfall Areas of the Northern Plains, USDA-SARE, $354,405 total; $1000 UW subaward (PI).

2011-12 PI: Carbon-rich soil amendments for ecological restoration of drastically disturbed rangeland sites. UW Ag Exp Station Competitive Grant, $52,729.

Kelleners:
Wyoming Center for Environmental Hydrology and Geophysics. 2016-2017. $89,557. Snow distribution and snowpack evolution affecting Wyoming mountain hydrology.

Wyoming Center for Environmental Hydrology and Geophysics. 2016-2017. $114,710. Hydrologic modeling in WyCEHG: Multiple approaches to modeling coupled systems.

Wyoming Center for Environmental Hydrology and Geophysics. 2016-2017. $103,517. Hillslope hydrology at NoName watershed: Connecting surface and subsurface water budget measurements and modeling.

Wyoming Center for Environmental Hydrology and Geophysics. 2013-2015. $200,000. Component modeling.

Zhu:

Department of Energy EPSCoR & University of Wyoming. 2016-2019. $450,000 (DOE) and $46,500 (UW). Nucleation, Growth, and Aggregation of Todorokite Nanoparticles from Both Geochemical and Materials Science Perspectives.

Roy J. Shlemon Center for Quaternary Studies. 2016-2017. $11,900. Phosphorus Speciation and Bioavailability Evolution During Soil Development in the Quaternary Period.

NSF Geobiology and Low-Temperature Geochemistry Program (EAR1529937). 2015-2018. $261,953. The Geochemical Processes Controlling Mn(III) and Vacancy Concentrations in Birnessite Structure.

School of Energy Resources, University of Wyoming. 2015-2016. $86,848. Pore-space Alteration Induced by Mineral Dissolution and Precipitation under Flow Conditions.

Wyoming Restoration and Reclamation Center. 2014-2016. $60,000. Trace Element Geochemistry of Soils in the Coalbed Natural Gas Produced Water Disposal Ponds in the Powder River Basin, Wyoming.

University of Wyoming Agriculture Experimental Station (AES) competitive Grants Program. 2014-2016. $74,302. Temporal and Spatial Variations of Soil Phosphorus Speciation in a Cold Semi-arid Climate.

Vaughan:

Bureau of Land Management National Landscape Conservation System Research Support Program; 2016-2017; Developing an Inventory and Monitoring Framework of Herbaceous Riparian Wetlands in the National Trails Management Corridor of the Upper Sweetwater River Basin, Wyoming; PI: J. Norton; $25,000.

Wyoming Department of Environmental Quality, Abandoned Mine Lands; 2016-2018; Geomorphic reclamation and landscape heterogeneity: An efficacy assessment of vegetation heterogeneity, geomorphic stability, wildlife habitat, and economics; PI: P. Stahl; $207,115.

UW College of Agriculture and Natural Resources Global Perspectives Grant Program; 2016-2017; International collaboration with World Agroforestry Centre (ICRAF) scientists: Environmental and human-induced drivers of soil organic carbon in savanna ecosystems; PI: K. Vaughan; $4,000.

Wyoming National Science Foundation EPSCoR Outside-the-Box Grants; 2016-2017; Spatial distribution of alpine permafrost and its influence on mountain hydrology and climate change in the Snowy Range Mountains, Wyoming; Co- PIs: K. Vaughan & L. van Diepen; $ 49,885.

Ellbogen Center for Teaching and Learning Professional Development Mini-Grants, University of Wyoming; 2015; Augmented Reality Sandbox construction; PI: K. Vaughan; $1,500.

Research, Scholarly, and Creative Activities Grant Program, California Polytechnic State University; 2014; Variability of Soil Redoximorphic Feature Expression in Seasonal Wetlands; PI: K. Vaughan; $13,440.

Agricultural Research Institute, California State University; 2014-2016; Development and documentation of a standard for visual sulfur reduction to identify seasonally inundated wetlands; PI: K. Vaughan; $40,000.

United State Department of Agriculture - Natural Resources Conservation Service in coordination with Oregon State University; 2013-2015; Quantification of outcomes generated using multi-scale geomorphic classification systems in predictive and update modes of digital soil mapping; Co PIs: J. Noller & K. Vaughan; $49,208 out of $94,074.

Agricultural Research Institute, California State University; 2012-2013; Soil Science New Investigator Funding; PI: K. Vaughan; $5,000.

Oreggia Foundation, California State University; 2011-2015; Soil Science Research Funds; PI: L. Moody; $40,000.

van Diepen:
Wyoming NSF EPSCoR-outside-the-Box grant: Spatial distribution of alpine permafrost and its influence on mountain hydrology and climate change in the Snowy Range Mountains, Wyoming. Co-PIs: Karen Vaughan, Linda van Diepen, and Andy Parsekian. (**$49,885**)

***DOE JGI CSP*:** Department of Energy's Joint Genome Institute, Community Sequencing Program. 2012. Microbial community dynamics in a long-term soil warming chronosequence. Received grant to sequence 2TB of RNA/DNA extracted from soil samples to study the effects of soil warming on microbial community composition and gene expression. Jeffrey Blanchard, Kristen DeAngelis, Jerry Melillo, Serita Frey, and Linda van Diepen (estimated to be equivalent to **~$50,000**).

APPENDIX C: Journal publications by current soils faculty (Sep. 2011 – Aug. 2016)

Stahl:

1. Curran, M.F. and P.D. Stahl. 2016. The importance for centralized databases for reclamation projects: Lessons learned from the Wyoming Reclamation and Restoration Center Oil and Gas Reclamation Database. Journal of Environmental Solutions for Oil, Gas, and Mining 1:31-43.
2. Gasch, C.K., S.V. Huzurbazar, A.F. Wick, and P.D. Stahl. 2015. Assessing impacts of crested wheatgrass and native species establishment on soil characteristics in reclaimed land using Bayesian posterior predictive distributions. Land Degradation and Development 27:521-531. DOI: 10.1002/ldr.2453
3. Sapkota, R.P and P. D. Stahl. 2015. Ecosystem restoration in Nepal: Needs and initiatives. Nepal Journal of Environmental Science 2:7-14.
4. Curran, M.F., T.M. Crow, K.M. Hufford, and P.D. Stahl. 2015. Forbs and greater sage grouse habitat restoration efforts: Suggestions for improving commercial seed availability and restoration practices. Rangelands 37(6): 211-216.
5. Vial, E.M., L.F. Gentry, D.G. Hopkins, A.C. Ganguli, and P.D. Stahl. 2014. Legacy effects of oil road reclamation on soil biology and plant community composition. Restoration Ecology. DOI:10.111/rec.12115
6. Gasch, C., A. F. Wick, S. Huzurbazar, P.D. Stahl. 2014. Baysian posterior predicitive distributions for assessing soil aggregation in undisturbed semiarid grasslands. Soil Science Society of America Journal 77: 1380-1390.
7. Gasch, C., S. Huzurbazar, P.D. Stahl. 2014. Description of aboveground and belowground spatial structure in sagebrush steppe following disturbance, reclamation and recovery. Soil Science Society of America: in press.
8. Gasch, C., S. Huzurbazar, P.D. Stahl. 2014. Measuring soil disturbance effects and assessing soil restoration success by examining distributions of soil properties. Applied Soil Ecology 76:102-111.
9. Curran, M.F., B.J. Wolff, P.D. Stahl. 2013. Approaching oil and gas pad reclamation with data management: a framework for the future. Journal of the American Society of Mining and Reclamation 2:195-204.
10. Gasch Salava, C., S. Enloe, P.D. Stahl, S.E. Williams. 2013. An aboveground-belowground assessment of ecosystem properties associated with exotic annual brome invasion. Biology and Fertility of Soils 49:919-928.
11. Dangi, S.R., P.D. Stahl, A.F. Wick, L.J. Ingram, and J.S. Buyer. 2012. Soil microbial community recovery in reclaimed soil on a surface coal mine site. Soil Science Society of America Journal 76:915-924.

Norton:

*Graduate student advisee; †Postdoctoral advisee

1. Okeyo*, M.J., J.B. Norton, and S. Koala, B. Waswa, J. Kihara, and A. Bationo. In press. Impact of reduced tillage and crop residue management on soil properties and crop yields in a long-term trial in western Kenya. Soil Research.
2. Hurisso†, T.T., U. Norton, J.B. Norton, J. Odhiambo, S.J. Del Grosso, G.W. Hergert, and D.J. Lyon. 2016. Dryland soil greenhouse gases and yield-scaled emissions in no-till and organic

winter wheat–fallow systems. Soil Science Society of America Journal doi:10.2136/sssaj2015.08.0295.

3. Lamb, J.N., K.M. Moore, J.B. Norton, E.C. Omondi, R. Laker-Ojok, D.N. Sikuku, D.S. Ashilenje, and J. Odera. 2015. A social networks approach for strengthening participation in technology innovation: lessons learnt from the Mount Elgon region of Kenya and Uganda. International Journal of Agricultural Sustainability DOI: 10.1080/14735903.2015.1025479.
4. Odhiambo*, J., U. Norton, D. Ashilende, E. Omondi, J.B. Norton. 2015. Weed dynamics during transition from conventionally tilled maize/bean intercropping to conservation agriculture practices in western Kenya. PLOS ONE DOI:10.1371/journal.pone.0133976.
5. Hurisso†, T.T., J.B. Norton, E.J. Mukhwana*, and U. Norton. 2015. Soil organic carbon and nitrogen fractions and sugarbeet sucrose yield in furrow-irrigated agroecosystems. Soil Science Society of America Journal: doi:10.2136/sssaj2015.02.0073.
6. Bista*, P., U. Norton, R. Ghimire, and J.B. Norton. 2015. Greenhouse gas fluxes and soil carbon and nitrogen following single summer tillage event. International Journal of Plant and Soil Science 6:183-193, DOI: 10.9734/IJPSS/2015/16234.
7. Day*, S.J., J.B. Norton, T. Kelleners, and C.F. Strom. 2015. Drastic disturbance of salt-affected soils in a semi-arid cool desert shrubland. Arid Land Res Manag 29:306-320, DOI: 10.1080/15324982.2014.962666.
8. Odhiambo*, J., U. Norton, E.C. Omondi†, D.S. Ashilende, D.N. Sikuku†, and J.B. Norton. 2014. Soil carbon and nitrogen mineralization and crop parameters in typical maize-bean intercropping in western Kenya. International Journal of Plant and Soil Science 5:127-142, DOI : 10.9734/IJPSS/2015/14476.
9. Ghimire*, R., J.B. Norton, P.D. Stahl, and U. Norton. 2014. Soil microbial substrate properties and microbial community responses under irrigated organic and reduced-tillage crop and forage production system. PLoS ONE 9(8): e103901.
10. Hurisso†, T.T., J.B. Norton, and U. Norton. 2014. Labile soil organic carbon and nitrogen within a gradient of dryland agricultural land-use intensity in Wyoming. Geoderma 226: 1-7.
11. Moore, K.M., J.N. Lamb, D.N. Sikuku†, D.S. Ashilenje, R. Laker-Ojok, J.B. Norton. 2014. Multiple knowledges for agricultural production: Implications for the development of conservation agriculture in Kenya and Uganda. J Ag Ed Extension 20:291-307.
12. Omondi†, E.C., J.B. Norton, D.S. Ashilenje. 2014. Performance of a local open pollinated maize variety and a common hybrid variety under intensive small-scale farming practices. African Journal of Agricultural Research 9:950-955.
13. Norton, J.B., H.R. Olsen*, L.J. Jungst*, D. Legg, and W.R. Horwath. 2014. Soil carbon and nitrogen storage in alluvial wet meadows of the southern Sierra Nevada Mountains. J Soils Sediments 14:34-43.
14. Ghimire*, R., J.B. Norton, and E. Pendall. 2014. Alfalfa-grass biomass, soil organic carbon, and total nitrogen under different management approaches in an irrigated agroecosystem. Plant Soil 374:173-184.
15. Hurisso†, T.T., J.B. Norton, U. Norton. 2013. Soil profile carbon and nitrogen in prairie, perennial grass–legume mixture and wheat-fallow production in the central High Plains, USA. Agriculture, Ecosystems & Environment 181:179-187.
16. Ghimire*, R., J.B. Norton, U. Norton, J.P. Ritten, P.D. Stahl, and J.M. Krall. 2013. Long-term farming systems research in the central High Plains. Renew Ag Food Sys 28:183-193.
17. Norton, J.B., E.J. Mukhwana*, and U. Norton. 2012. Loss and recovery of soil organic carbon and nitrogen in a semiarid agroecosystem. Soil Sci Soc Am J 76:505-514.

18. Kelleners, T.J., and J.B. Norton. 2012. Determining water retention in seasonally frozen soils using Hydra impedance sensors. Soil Sci Soc Am J 76:30-50.
19. Norton, J.B., L.J. Jungst*, U. Norton, H.R. Olsen*, K.W. Tate, W.R. Horwath. 2011. Soil carbon and nitrogen storage in upper montane riparian meadows. Ecosystems 14:1217-1231.
20. Norton, J.B. 2011. Nitrogen source, timing, and rate alternatives for furrow-irrigated sugarbeet. Crop Management:10.1094/CM-2011-0829-1001-RS.

Kelleners:

1. Engda, T.A., **T.J. Kelleners**, G.B. Paige, and A.L. Hild. 2016. Rainfall, evapotranspiration, and soil moisture as biomass predictors for Wyoming rangelands. Arid Land Research and Management 30: 445-459.
2. **Kelleners, T.J.**, J. Koonce, R. Shillito, J. Dijkema, M. Berli, M.H. Young, J.M. Frank, and W.J. Massman. 2016. Numerical modeling of coupled water flow and heat transport in soil and snow. Soil Science Society of America Journal 80:247-263.
3. Poudyal, S., V.D. Zheljazkov, C.L. Cantrell, and **T.J. Kelleners**. 2016. Coal-bed methane water effects on Dill and its essential oils. Journal of Environmental Quality 45:728-733.
4. Engda, T.A. and **T.J. Kelleners**. 2016. Soil moisture-based drought monitoring at different time scales: A case study for the US Great Plains. Journal of the American Water Resources Association 52:77-88.
5. Kaur, G. A. Garcia y Garcia, U. Norton, T. Persson, and **T. Kelleners**. 2015. Effects of cropping practices on water-use and water productivity of dryland winter wheat in the high plains ecoregion of Wyoming. Journal of Crop Improvement 29(5):491-517.
6. Day, S.J., J.B. Norton, **T.J. Kelleners**, and C.F. Strom. 2015. Drastic disturbance of salt-affected soils in a semi-arid cool desert shrubland. Arid Land Research and Management 29:306-320.
7. **Kelleners, T.J.** 2013**.** Coupled water flow and heat transport in seasonally frozen soils with snow accumulation. Vadose Zone J. doi:10.2136/vzj2012.0162.
8. Fares, A., M. Temimi, K. Morgan, and **T.J. Kelleners**. 2013. In situ and remote soil moisture sensing technologies for vadose zone hydrology. Vadose Zone J. doi:10.2136/vzj2013.03.0058.
9. **Kelleners, T.J.** and A.K. Verma. 2012. Modeling CO_2 production and transport in a mixed-grass rangeland soil. Vadose Zone J. 11:10.2136/vzj2011.0205.
10. Verma, A.K. and **T.J. Kelleners**. 2012. Depth-wise CO_2 production and transport in a Wyoming rangeland soil. Soil Sci. Soc. Am. J. 76:821-828.
11. **Kelleners, T.J** and J.B. Norton. 2012. Determining water retention in seasonally frozen soils using Hydra impedance sensors. Soil Sci. Soc. Am. J. 76:36-50.

Zhu:

(* indicate students or post-docs)

1. *Gu C., Wang Z., Kubicki J.D., *Wang X. and **Zhu M.**, X-ray Absorption Spectroscopic Quantification and Speciation Modeling of Sulfate Adsorption on Ferrihydrite Surfaces, *Environ. Sci. Technol.*, **2016** (In press).
2. Wang X., **Zhu M.**, Koopal L.K., Li W., Xu W., Liu F., Zhang J., Liu Q., Feng X., Sparks D.L., Effects of Crystallite Size on the Structure and Magnetism of Ferrihydrite, ***Environ. Sci.: Nano***, **2016**, ***3*:**190-202

3. Zhao H., **Zhu M.**, Li W., Elzinga E.J., Villalobos M., Liu F., Zhang J., Feng X., and Sparks D.L., Redox Reactions between Mn (II) and Hexagonal Birnessite Change its Layer Symmetry, *Environ. Sci. Technol.*, **2016**, *50* (4):1750–1758
4. **Zhu M.**, Frandsen C., Wallace A.F., Legg B, Khalid S., Zhang H., Morup S., Banfield J.F. and Waychunas G.A. Precipitation Pathways for Ferrihydrite Formation in Acidic Solutions, *Geochim. Cosmochim. Acta*, **2016**,172:247
5. *Wang X., *Gu C., Feng X. and **Zhu M.**, Sulfate Local Coordination Environment in Schwertmannite, *Environ. Sci. Technol.*, **2015**, 49(17):10440
6. Feng X., Wang X., **Zhu M**., Koopal L.K., Xu H., Wang Y., Liu F., Effects of Phosphate and Silicate on the Transformation of Hydroxycarbonate Green Rust to Ferric Oxyhydroxides, *Geochim. Cosmochim. Acta*, **2015**, 17:1
7. Wang X., **Zhu M**., Lan S., Ginder-Vogel M., Liu F., Feng X., Formation and Secondary Mineralization of Ferrihydrite in the Presence of Silicate and Mn(II), *Chem. Geol.*, **2015**, 415: 37
8. Wang X., Lan S., **Zhu M.**, Ginder-Vogel M., Yin H., Liu F., Tan W. and Feng X. The Presence of Ferrihydrite Promotes Abiotic Mn(II) Oxidation and Formation of Birnessite. *Soil Sci. Soc. Am. J.*, **2015**, 79, 5:1297
9. Li H., Liu F., **Zhu M.**, Feng X., Zhang J. and Yin H., Structure and Properties of Co-doped Cryptomelane and its Enhanced Removal of Pb^{2} + and Cr^{3+} from Wastewater, *J. Environ Sci.*, **2015**, 24:77
10. Yin H., Liu Y., Koopal L. K., Feng X., Chu S., **Zhu M.**, Liu F., High Co-doping promotes the transition of birnessite layer symmetry from orthogonal to hexagonal, *Chem. Geol.* **2015**, 410:12
11. Yin H., Dai X., **Zhu M.**, Li F., Feng X., Liu F., Fe-doped cryptomelane Synthesized by Refluxing at Atmosphere: Structure, Properties and Photocatalytic Degradation of Phenol, *J. Hazard. Mater.* **2015**, 410:12
12. Yin H., Feng X., Tan W., Koopal L.K., Hu T., **Zhu M.**, Liu F. Structure and Properties of Vanadium (V)-doped Hexagonal Turbostratic Birnessite and its Enhanced Scavenging of Pb^{2+} from Solutions, *J. Hazard. Mater.*, **2015**, 288:80
13. Legg B. A., **Zhu M.**, Comolli L.R., Gilbert B., Banfield J.F., Impacts of Ionic Strength on Three-Dimensional Nanoparticle Aggregate Structure and Consequences for Environmental Transport and Deposition, *Environ. Sci. Technol.*, **2014**, *48* (23):13703
14. Legg B. A., **Zhu M.**, Comolli L.R., Gilbert B., Banfield J.F., Determination of the Three-Dimensional Structure of Ferrihydrite Nanoparticle Aggregates, *Langmuir*, **2014**, *30* (33):9931
15. **Zhu M.**, Northrup P., Shi C., Billinge S.J.L., Sparks, D.L., and Waychunas, G.A., The Structure of Sulfate Adsorption Complexes on Ferrihydrite, *Environ. Sci. Technol. Lett.*, **2014**, *1* (1): 97
16. **Zhu M.**, Puls B. W., Zhang H., Kubicki J. and Waychunas G. A. *In situ* Structural Characterization of Ferric Iron Dimers in Aqueous Solutions: Identification of μ-oxo Species, *Inorg. Chem.* **2013**, *52* (12): 6788
17. Li W., Wang Y.-J., **Zhu M.**, Zhou D., Phillips B. L., Sparks D. L., Inhibition Mechanisms of Zn Precipitation on Aluminum Oxide by Glyphosate, *Environ. Sci. Technol.*, **2013**, *47* (9):4211
18. **Zhu M**., Legg. B., Zhang H., Gilbert B., Ren Y., Banfield, J. and Waychunas, G.A., Early-stage Formation of Iron Oxyhydroxides During Neutralization of Simulated Acid Mine Drainage Solutions, *Environ. Sci. Technol.*, **2012**, 46(15):8140

19. Livi K. J. T., Lafferty B. J., **Zhu M**., Zhang S., Gaillot A. and Sparks D. L., Electron Energy-Loss Safe-Dose Limits for Manganese Valence Measurements in Environmentally Relevant Manganese Oxides, *Environ. Sci. Technol.*, **2012**, 46(*2*):970
20. **Zhu M**., Farrow C. L., Post J. E., Livi K. J. T., Billinge S. J. L., Ginder-Vogel M. and Sparks D. L., 2012, Structural Study of Poorly-Crystalline Abiotic and Biotic Mn-oxides Using Atomic Pair Distribution Function, *Geochim. Cosmochim. Acta.,* **2012***,* 81:39
21. Zhang H., Bayne M., Fernando S., Legg B., **Zhu M**., Lee Penn R., and Banfield J. F., Size - Dependent Bandgap of Nano-Goethite, *J. Phys. Chem. C*., **2011**, 115(36):17704

Vaughan:

1. **Vaughan, K**., F. Miller, N. Navarro, and C. Appel. Development and documentation of a standard for visual sulfur reduction to identify seasonally inundated wetlands. Soil Sci. Soc. Am. J. *In press*.
2. Verma, P., **K. Vaughan**, K. Martin, E. Pulitano, J. Garrett, and D. Piirto. Integrating indigenous knowledge and western science into forestry, natural resources, and environmental programs. J. Forest. *In press*.
3. Appel, C., **K. Vaughan**, B. Swan, M. Wallace, C. Stubler, and P. Verma. 2014. Effect of a soil microbial activity laboratory on student learning. NACTA J. 58:129-134.
4. **Vaughan, K.L.**, P.C. McDaniel, and W. Phillips. 2011. Episodic soil succession on basaltic lava fields in a cool, dry environment. Soil Sci. Soc. Am. J. 75:1462-1470.

van Diepen:

1. Morrison, E.W., S.D. Frey, J.J. Sadowsky, **L.T.A. van Diepen**, W.K. Thomas, and A. Pringle, 2016. Chronic nitrogen additions fundamentally restructure the soil fungal community in a temperate forest. **Fungal Ecology** 23: 48-57.
2. **Van Diepen**, **L.T.A.**, S.D. Frey, C.M. Sthultz, E.W. Morrison, R. Minocha, and A. Pringle, 2015. Changes in litter quality caused by simulated nitrogen deposition reinforce the N-induced suppression of litter decay. **Ecosphere** 6(10): 205. http://dx.doi.org/10.1890/ES15-00262.1
3. Crowther, T.W., S.M. Thomas, D.S. Maynard, P. Baldrian, K. Covey, S.D. Frey, **L.T.A. van Diepen**, and M.A. Bradford, 2015. Biotic interactions mitigate soil microbial feedbacks to climate change. **PNAS** 112: 7033-7038.
4. DeAngelis K.M., G. Pold, B.D. Topcuoglu, **L.T.A. van Diepen**, R.M. Varney, J.L. Blanchard, J. Melillo, and S.D. Frey, 2015. Long-term forest soil warming alters microbial communities in temperate forest soils. **Frontiers in Microbiology** 6: article 104.
5. **Van Diepen**, **L.T.A,** E.A. Hobbie, and J.E. Mohan, 2014. Fungi, ecosystems and global change. **Fungal Ecology** 10: 1-2.
6. Andrew, C.J., **L.T.A. van Diepen**, R.M. Miller, and E.A. Lilleskov, 2014. Quantifying aspen-associated mycorrhizal fungal production and respiration as a function of changing CO_2, O_3, and climatic variables. **Fungal Ecology** 10: 70-80.
7. Hobbie, E.A., K.S. Hofmockel, **L.T.A. van Diepen**, E.A. Lilleskov, A.P. Ouimette, and A.C. Finzi, 2014. Fungal carbon sources in a pine forest: evidence from a ^{13}C-labeled global change experiment. **Fungal Ecology** 10: 91-100.
8. Hobbie, E.A., K.S. Hofmockel, **L.T.A. van Diepen**, E.A. Lilleskov, A.P. Ouimette, and A.C. Finzi, 2014. Fungal functioning in a pine forest: evidence from a ^{15}N-labeled global change experiment. **New Phytologist** 201: 1431-1439.
9. **Van Diepen, L.T.A.**, Å. Olson, K. Ihrmark, J. Stenlid, and T.Y. James, 2013. Positive selection and extensive trans-specific polymorphism at the mating type locus of the root decay fungus *Heterobasidion.* **Molecular Biology and Evolution** 30: 2286–2301.

10. Van Diepen, L.T.A., E. Entwistle, and D.R. Zak, 2013. Chronic nitrogen deposition and the composition of active arbuscular mycorrhizal fungi. **Applied Soil Ecology** 72: 62-68.
11. Nave, L.E., K.J. Nadelhoffer, J.M. Le Moine, **L.T.A. van Diepen**, J.K. Cooch, and N.J. van Dyke, 2013. Nitrogen uptake by trees and mycorrhizal fungi in a successional northern temperate forest: insights from multiple isotopic methods. **Ecosystems** 16: 590-603.
12. Olson, Å., A. Aerts, F. Asiegbu, L. Belbahri, O. Bouzid, A. Broberg, B. Canbäck, P.M. Coutinho, D. Cullen, K. Dalman, G. Deflorio, **L.T.A. van Diepen**, C. Dunand, S. Duplessis, M. Durling, P. Gonthier, J. Grimwood, C.G. Fossdal, D. Hansson, B. Henrissat, A. Hietala, K. Himmelstrand, D. Hoffmeister, N. Högberg, T.Y. James, M. Karlsson, A. Kohler, U. Kües, Y-H. Lee, Y-C. Lin, M. Lind, E. Lindquist, V. Lombard, S. Lucas, K. Lundén, E. Morin, C. Murat, J. Park, T. Raffaello, P. Rouzé, A. Salamov, J. Schmutz, H. Solheim, J. Ståhlberg, H. Vélëz, R.P. de Vries, A. Wiebenga, S. Woodward, I. Yakovlev, M. Garbelotto, F. Martin, I.V. Grigoriev, and J. Stenlid, 2012. Insight into trade-off between wood decay and parasitism from the genome of a fungal forest pathogen. **New Phytologist** 194: 1001-1013.
13. **Van Diepen, L.T.A.**, E.A. Lilleskov, and K.S. Pregitzer, 2011. Simulated nitrogen deposition affects community structure of arbuscular mycorrhizal fungi in northern hardwood forests. **Molecular Ecology** 20: 799-811.
14. James, T.Y., M. Lee, and **L.T.A. van Diepen**, 2011. A single mating-type locus composed of homeodomain genes promotes nuclear migration and heterokaryosis in the white-rot fungus *Phanerochaete chrysosporium*. **Eukaryotic Cell** 10: 249-261.

APPENDIX D: National/international awards obtained by current soils faculty

Stahl:
-University of Wyoming Faculty Internationalization Award, April, 2012
-Reclamation Researcher of the Year 2005, American Society for Mining and Reclamation, June 2005.
-University of Wyoming Range Club "Outstanding Professor", December, 2001
-University of Wyoming EPSCoR Faculty Success Story, 2000.

Norton:
-Colorado State University Extension Team Award for Livestock Mortality Composting for Large and Small Operations in the Semi-arid West Extension Program, 2012
-American Society of Agronomy Educational Materials Certificate of Excellence for Livestock Mortality Composting for Large and Small Operations in the Semi-arid West, 2012

Vaughan:
-Awarded the President's Diversity Award for work in creating a new minor, Indigenous Studies in Natural Resources at Cal Poly. 2016 (together with Verma, Pulitano, Martin, and Piirto)
-Soil Science Society of America, Association of Women Soil Scientists Mentoring Award recipient. 2013

APPENDIX E: Service to professional organizations by current soils faculty

Stahl:
-President, American Society of Mining and Reclamation, 6/6/2016 -8/6/2017.

Norton:
-Editorial board, The Scientific World Journal, Soil Science section
-2009-present USAID SANREM-CRSP Technical Review Committee.
-USDA Western Nutrient Management committee
-Soil Science Society of America: Current vice-chair of the cover-crop management community
-Western Soil Science Society (President, 2010-11)

Kelleners:
-Associate editor, Soil Science Society of America Journal (2016-present)

Zhu:
-Associate Editor *Geochemical Transactions (2016 – present)*

Vaughan:
-Advancing Pedology Colloquium Committee, Soil Science Society of America (2016-2018)
-USDA-NRCS National Technical Committee for Hydric Soils, elected academic representative (2013 – present)
-National Collegiate Soil Judging Contest Committee – region 6 representative, Soil Science Society of America (2013 – present)
-Chair-elect Pedology division, Soil Science Society of America (chair in 2016-2017)

van Diepen:

-Guest Editor: Fungal Ecology, special issue August 2014; Fungi in a changing world: The role of fungi in ecosystem response to global change.
-Co-organizer: Symposium on "Fungi in a Changing World" at Mycological Society of America annual meeting in 2012.

APPENDIX F: Average student credit hours for SOIL courses over past 5 academic years (September 2011 – August 2016)

				number of times	11/12		12/13		13/14		14/15		15/16		student total		student credit hours per year	
U	G	course title	credit	taught	U	G	U	G	U	G	U	G	U	G	U	G	U	G
2010	-	Intro	4	5	85	-	64	-	64	-	51	-	64	-	328	-	262.4	-
3130	-	Env. Qual.	3	3	24	-	-	-	-	-	30	-	22	-	76	-	76.0	-
4100	5100	Physics	3	5	7	6	5	7	5	12	4	5	3	12	24	42	14.4	25.2
4105	5105	Physics Lab.	2	5	1	6	3	3	1	12	2	5	2	7	9	33	3.6	13.2
4120	5120	Genesis	4	5	44	9	32	4	41	4	27	4	17	5	161	26	128.8	20.8
4130	5130	Chemistry	3	4	3	12	-	-	2	6	1	1	0	3	6	22	4.5	16.5
4140	5140	Microbiol.	4	5	24	5	20	5	14	11	14	9	16	9	88	39	70.4	31.2
4150	5150	Forest+Range	3	5	5	3	7	6	7	3	7	2	9	0	35	14	21.0	8.4
4160	5160	Fertility	3	3	18	5	-	-	12	9	-	-	14	14	44	28	44.0	28.0
4590	5590	SP: Mineralogy	3	1	-	-	-	-	-	-	-	-	0	6	0	6	0	18.0
-	5110	Modeling	4	5	-	9	-	9	-	9	-	8	-	7	-	42	-	33.6
Total student credit hours per year																	625.1	194.9
Student credit hours per FTE per year																	304.9	95.1

Note: Student credit hours per year = student total × credit / number of times taught