WSU Five-Year Program Review
Self-Study
2014-2019

DEPARTMENT OF EARTH & ENVIRONMENTAL SCIENCES
College of Science

Department/Program: EARTH & ENVIRONMENTAL SCIENCES

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1. CONTEXT AND STRATEGIC PLANNING

1.1 Background:

For more than five decades, Weber State University has successfully pursued a dual mission by offering a wide range of baccalaureate and graduate programs while meeting regional community-college needs. Our vision is for Weber State University to be the national model for a dual-mission university that integrates learning, scholarship and community (WSU, 2012).
https://www.weber.edu/universityplanning/Vision_and_values.html

The Department of Earth and Environmental Sciences is one of seven departments within the College of Science (CoS) at Weber State University. It provides undergraduate education in geology, hydrology, environmental science, and geospatial technologies (remote sensing and geographic information science) for students wishing to complete the following degrees: Bachelor of Science in geology; Bachelor of Arts in geology; Bachelor of Science in applied environmental geoscience; and Bachelor of Science in Earth science teaching. The department supports other degree programs on campus by providing minor programs of study in geology, Earth science teaching, and geospatial studies, as well as geoscience emphasis areas for students pursuing a Bachelor of Integrated Studies (BIS). An institutional certificate of proficiency in geospatial analysis is also offered. The department also provides service courses for other majors and minors, including the Bachelor of Science in botany (Botany Department, College of Science), Bachelor of Science in zoology (Zoology Department, College of Science), Bachelor of Science in geography (Geography Department, College of Social and Behavioral Sciences), Environmental Studies Minor (interdisciplinary), and the Urban and Regional Planning Emphasis (College of Social and Behavioral Sciences). EES also offers an introductory Earth science course (GEO 1350 PS) designed for Elementary Education majors (College of Education). Lastly, the Department of Earth and Environmental Sciences supports the broader mission of the University by providing physical-science (PS) general-education courses for all students and by engaging the local community through Earth science-related-outreach activities and responses to public inquiries. Appendix G provides a brief history of the Department.

Unique features of the department's programs include the integration of a traditional geoscience curriculum with course work in the growing field of geospatial technologies at the undergraduate level, an emphasis on field-based learning, robust support for undergraduate research, well equipped analytical labs, and a cost-effective summer field camp for geology majors. We are particularly proud of our accomplishments in the area of undergraduate research. In the past five years, approximately 120 students (students were counted more than once if they participated in multiple UR projects) associated with the Department of Earth and Environmental Sciences (majors, minors, and microbiology students working with Carie Frantz) participated in 14 faculty-guided undergraduate research projects, resulting in approximately 40 presentations at national or regional scientific conferences and/or the annual WSU UR Symposium (see Section 6.7.3 and Appendix H). Faculty members also encourage and support geoscience-related

extracurricular activities and the department is the home to an active Geology Club and Sigma Gamma Epsilon chapter (national honor society for Earth science students).

Student retention and timely graduation are a focus of the faculty and staff. Based on data provided to the department by the Office of Institutional Effectiveness, we had a total of 79 graduates (bachelor's degrees and certificates) over the last 5 years, averaging 15.8/year (Appendix A). Total student credit hours (SCHs) ranged between 5,729 (2014-15) and 6390 (2018-19) over the same period (Appendix A). The variation in SCHs roughly correlates with overall university enrollment trends. In Fall 2019, the distribution of majors (including double/dual majors) in our various degree and certificate programs was:

Geology (BS/BA):	63
Applied Environmental Geoscience (BS):	31
Earth Science Teaching (BS):	3
Geospatial Analysis (Certificate):	12
TOTAL	109

Lastly, the Department of Earth and Environmental Sciences has benefited greatly from a change in our academic home and facilities since the time of our last program review (2012-2013). The Department, along with the rest of the College of Science, is now housed in the attractive and inviting **Tracy Hall Science Center**, which opened in August 2016. Several EES faculty members were significantly involved in the planning and programming for this LEED Gold-certified building, as well as leading the ongoing effort to fully equip the College's various teaching and research laboratories.

1.2 Strategic Planning:

Recently, the College of Science has been engaged in strategic planning and has identified four strategic initiatives, on which each of its departments/programs will collaborate to achieve: (1) Develop a new interdisciplinary Environmental Science BS; (2) Revitalize our various secondary science and mathematics teaching programs; (3) Focus on workforce readiness across all degrees and programs; and (4) Promote teaching excellence and the widespread adoption of high-impact educational experiences (HIEE) and active-learning pedagogies. The Department of Earth and Environmental Sciences (EES) has identified department-level strategic initiatives (section 1.3) that we think will advance our programs and substantially contribute to our college-level goals.

The EES faculty and staff are very much focused on the future of our department and have expended considerable thought and effort over the past two years to analyze and revise our curricula (see section 3.3 and Appendix J), in conjunction with major national efforts (NSF-sponsored summits on *The Future of Undergraduate Geoscience Education*), to better prepare students for the challenges of the 21st century. Our major short-term goals for the 2018-2019 academic year were to finalize our curricula revisions and to rebrand the Department of Geosciences as the Department of Earth and Environmental Sciences. These goals were successfully accomplished. In addition, in Fall 2018, the Provosts Office provided funding for 1.5 new faculty positions in the CoS in support of the College's Environmental Science initiative and the joint EES-Geography Geospatial Education

program. EES faculty chaired successful searches for these two positions, as well as a search for a new EES Lab Manager, also supported by new funding from the Provosts Office. The environmental science search focused on bringing applied climate science expertise to the College and the departmental home of the successful candidate was left open. Dr. Caitlin Tems (PhD University of Southern California) accepted the Dean's offer and it was decided that EES will be her departmental home. Dr. Ryan Frazier (PhD University of British Columbia) was selected for the geospatial science position and he has a joint appointment across two colleges (EES/CoS and Geography/S&BS), a bold and exciting cross-college collaboration. Lastly, Sara Summers (WSU class of 2010, MS University of Notre Dame) joined the EES team as Lab Manager in January 2019.

Going forward, we are excited to leverage these recent accomplishments and new faculty/staff positions to achieve our strategic goals, outlined below. We also recognize the great investment that has been made in our department, and we will strive to ensure this investment pays significant dividends in terms of student success and meeting strategic goals.

1.3 Strategic Goals:

The long-term employment outlook for geoscience graduates is very good, especially if graduates are willing to relocate to other states. The Bureau of Labor Statistics predicts that the demand for geoscientists, hydrologists, and environmental scientists will grow 6-8% (2018-2028), faster than the average rate of job growth. In addition, the American Geosciences Institute (AGI) projects a workforce shortage of 90,000 geoscientists nationwide by 2022 due to increasing demand and the looming retirement of many senior geoscientists. Even greater job growth (19%) is projected for geospatial analysts and cartographers, as geospatial technologies are evolving rapidly and are being applied across an increasing number of job sectors. Regionally, there is also a robust demand for well-trained secondary science and mathematics teachers. We want to recruit and train future geoscientists, environmental scientists, geospatial professionals, and Earth science educators to help meet this growing demand, as these jobs will be critical to securing a healthy, prosperous, and sustainable future. Therefore, we have prioritized three initiatives, aligned with the College of Science's strategic plan:

• **Initiative 1**: Considering the energy and expertise that recent hires in the College of Science have brought to WSU (including the new applied climate science and geospatial science positions discussed above), we think the College is now in a very strong position to develop and implement a new, interdisciplinary **Environmental Science BS** degree, with an emphasis on applied science and workforce skills. Dean Easter-Pilcher tasked EES chairperson Rick Ford to facilitate discussion and collaboration across all science and mathematics departments to create this new degree. The task force developed the curriculum for this new degree during Fall semester 2019. The new degree is presently working its way through the curriculum-review process. When approved, this will be the most interdisciplinary undergraduate environmental science program in the Utah System of Higher Education, connecting students with the environmental expertise that exists among the life, physical, geological, and mathematical sciences. (UVU has an Environmental Science & Management BS, offered by the Department of Earth Science, with a strong water

treatment/physical science emphasis. Dixie State University is proposing a new Earth, Energy, and Environment BS, offered by the Department of Physical Sciences.)

Appendix I contains a draft of the proposed Bachelor of Science in environmental science.

• **Initiative 2:** Skills in geospatial science (i.e., mapping and problem solving using a wide variety of remote-sensing, environmental, drone, and "big" data) are becoming increasingly important in the day-to-day work of many STEM professionals. Our strategy to help WSU students develop these skills is to fully implement **NUGeoTec** -- the cross-college, **geospatial education program** developed by Michael Hernandez (EES/CoS) and Eric Ewert (Geography/S&BS) (https://www.weber.edu/nugeotec). With support from a major NSF grant, and input from nationally recognized experts (NUGeoTec Advisory Board) and national disciplinary organizations, Michael and Eric have designed courses, certificates and a minor that will provide students with the competencies and skills that the 21st-century geospatial workforce is expected to require. The curriculum revisions associated with this effort were approved during the 2018-2019 academic year. In addition, the new geospatial faculty position discussed above will allow the two departments to increase capacity by offering more sections of key courses and permit the development of new courses related to emerging skills and technologies (e.g., data acquisition and analysis using drones).

• **Initiative 3:** The K-12 educational environment is rapidly changing and the College of Science is presently in a good position to examine and revise, as needed, its various secondary science and mathematics teaching degrees to insure we are providing the best possible preparation for a new generation of science and math educators. The Department of Earth and Environmental Sciences will participate in this **revitalization of CoS teaching programs** by updating our Earth Science Teaching major (BS) and minor. We plan to consult with classroom teachers (including alumni of our program), district science specialists, and the USBE about possible curricular changes. One possible change that will be examined will be to see if our curriculum could be revised such that graduates received both an endorsement for secondary Earth Science and AP Environmental Science. Graduates of such an Earth and Environmental Science Teaching degree (BS) could be very attractive to local school districts, and this interdisciplinary teaching degree would align nicely with the College's goal to be a leader in environmental education in northern Utah.

2. MISSION STATEMENT

2.1 Weber State University Mission Statement:

Weber State University provides associate, baccalaureate and master degree programs in liberal arts, sciences, technical and professional fields. Encouraging freedom of expression and valuing diversity, the university provides excellent educational experiences for students through extensive personal contact among faculty, staff and students in and out of the classroom. Through academic programs, research, artistic expression, public service

and community-based learning, the university serves as an educational, cultural and economic leader for the region. *(approved by Board of Regents July 2011)*

The University interprets its mission and assesses its outcomes through the lens of three core themes -- *ACCESS*, *LEARNING*, and *COMMUNITY*.
(https://www.weber.edu/universityplanning/Assess_core_themes.html)

2.2 Departmental Mission and Vision: *(revised October 2019)*

• **Mission:** To advance Earth and environmental science literacy, education, research, community and professional service, and stewardship of Earth's inhabitants and life-sustaining systems.

• **Vision:** To be the premier undergraduate Earth and environmental science program in Utah and the Intermountain West, focusing on student success, access, community engagement, and the training of the next generation of geoscientists, environmental scientists, geospatial professionals, and Earth science educators.

2.3 Alignment of Departmental Initiatives to Academic Affairs' Objectives:
In 2019 the Provost's Office/Academic Affairs set university-wide objectives related to value/quality, affordability, and access/growth as a means of broadly promoting student success. In its annual strategic planning report to the dean and provost, each department is asked how its work aligns with these goals. The Department of Earth and Environmental Sciences' 2018-2019 report is summarized below.

• **Value/Quality:** High-impact educational experiences (HIEEs) are central to the teaching and learning culture of our department, including active-learning activities in large general education courses and project-based instruction, undergraduate research (UR), field trips, and study abroad opportunities for departmental majors. We have a long history of supporting **undergraduate research**, even before it received the institutional support and recognition that it now enjoys on our campus. However, we want to increase the level of participation in UR by our majors. With a small faculty, we think the best way to do this is through the use of course-based undergraduate research experiences (CUREs). Carie Frantz has become a campus leader in the use of CUREs in her interdisciplinary upper-division courses (Geomicrobiology GEO/MICR 3753 and Geochemistry GEO/CHEM 4550). As a result of the curriculum changes recently approved, all Geology and Applied Environmental Geoscience majors will be required to take one of these courses as part of their bachelor's degree.

We organized and established the Geoscience Advisory Council (GAC) in Fall 2013 (renamed the **Earth and Environmental Sciences Advisory Council**/EESAC in 2018). This group of approximately 15 departmental alumni and friends of the department has held regular biannual meetings (fall and spring) since that time. In addition to providing regular feedback about workforce trends and hiring, the EESAC has planned and executed two very successful alumni events aimed at reconnecting graduates to the department: Antelope Island Picnic and GeoHike (October 2015); THSC Open House & Tailgate Party

(October 2017). The EESAC has also been instrumental in providing internships for our students and providing feedback regarding proposed changes to our curricula and department name. The EESAC is also planning an Earth Science Career Day for Spring 2020, which will bring department alumni back to campus to share information and advice with our students about their career paths as professionals. In addition, we will continue to closely monitor employment trends and professional licensing requirements and to adjust course content and other department activities accordingly. The EESAC is the primary tool to be used to achieve this goal. We will also continue to utilize the robust workforce-related resources provided by AGI. We are fortunate that the geoscience community is very much focused on community and graduate success at the national level.

• **Affordability:** Throughout its existence, our department has been able to provide exceptional opportunities for student learning and to support student success with its very modest annual budget and a long-standing commitment to keep course fees affordable. All faculty and staff understand and support WSU's Development efforts, and expend extra effort to secure funding that will help raise the stature of Weber State University and also help our students. We have been active in securing external and internal grant support, as well as generous donations from alumni, faculty, and friends of the department. Collectively, these have helped us to provide our students with a wide range of high-impact opportunities that improve student learning and success and better prepare them for the workforce.

Most geology programs across the nation require students to complete a field-intensive capstone course known as **"summer field camp."** Nationally, the cost of a 4- to 6-week field camp course commonly exceeds $3000. EES offers what may be the most inexpensive field camp in the country (tuition for 4 credits plus $500 course fee). We can do this only because we offer the course every other summer and our faculty teach the course as part of their regular load, saving instructor compensation costs. We will strive to maintain our high-quality and affordable field camp, but this will be a challenge in the face or our growing number of majors (discussed below). If student demand necessitates offering field camp every summer, we will have to offer faculty or adjunct instructors supplemental pay to teach the course. This issue will be studied over the coming year.

Effective advising (see section 5) and efficient degree pathways are key to ensuring affordability. Over the next few years, the College of Science is dedicated to exploring new associate degrees and certificates as stackable credentials that may benefit our students. As part of this effort, EES will collaborate with the Departments of Physics and Chemistry & Biochemistry to determine if a new Associate of Applied Science (AAS) in physical science would make sense as a "pre-major" for students who may be attracted to the various bachelor degrees offered by our three departments.

• **Access/Growth:** As a department, we strongly support Academic Affairs' access/growth objective. EES has long partnered with Continuing Education to offer evening classes at our Ogden and Davis Campuses. Beginning in 2016, we have supported multiple **concurrent enrollment** sections of *Dynamic Earth: Physical Geology* (GEO 1110 PS), first at Weber Innovation High School (Weber School District), and then in 2017 at Utah Military Academy

(Ogden). In Fall 2018 we added a concurrent enrollment section, offered on the main campus, for NUAMES North students. We are also beginning to look at the possibility of offering a concurrent enrollment course in partnership with the Davis School District.

EES faculty, notably Elizabeth Balgord and Marek Matyjasik, have been involved in grant-supported efforts to increase the **recruitment of Earth science majors** from underrepresented groups. Our department, and the national geoscience community, have made significant progress with respect to the issue of gender equality. However, the geosciences still struggle with the issue of ethnic diversity. In academic year 2016-17, using funding from a USHE StepUP grant ($74K), Liz and Marek worked with a science teacher at Weber Innovation HS to develop the concurrent enrollment course discussed above, and to offer a field-based summer-bridge course, which included extended field trips to Bryce Canyon and Yellowstone National Parks. The goal of this work was to use high-impact learning experiences to increase the recruitment and retention of underrepresented groups in STEM fields. Using the lessons learned from this work, Elizabeth Balgord, Marek Matyjasik, and Carie Frantz submitted and were awarded a major 3-year NSF grant (~$325K) for a project titled "GETUP" (Geoscience Education Targeting Underrepresented Populations). Work on this grant has begun and will be a major departmental focus for its duration.

From 2008 to 2013, the number of departmental majors, across all degree programs, increased from 57 to 90 (58%). This period of rapid growth was challenging, and paralleled the national trend in geoscience enrollments as reported by AGI. More recently, with the uncertainty surrounding environmental regulation and remediation at state and federal levels, coupled with the volatility in geologic commodity prices (oil, gas, minerals), AGI reports that, nationally, undergraduate geoscience enrollments have remained relatively steady since 2012. However, our number of majors increased to 110 in Fall 2018, another 22% increase since 2013. [The official third-week major count, which does not include double/dual majors, for Fall semester 2019 indicates a decrease in departmental majors to 88.]

3. CURRICULUM

3.1 Types of Degrees Offered:

The Department of Earth and Environmental Sciences offers four degrees and one institutional certificate:

• **Geology BS** -- 55 credit hours of required geoscience courses, 24-27 credit hours of required support courses (math, chemistry, & physics), no minor required.

• **Geology BA** – 38 credit hours of required geoscience courses, 13-21 credit hours of required support courses (math, botany, chemistry, & physics), no minor required.

• **Applied Environmental Geosciences BS** – 53-55 credit hours of required geoscience courses, 24-27 credit hours of required support courses (math, chemistry, & physics), no minor required.

• **Earth Science Teaching BS** – 42 credit hours of required geoscience courses, 27-30 credit hours of required support courses (math, chemistry, physics, and history), 24 credit hours of required education courses, and 9 credit hours of required education support courses, no minor required.

• **Geospatial Analysis Certificate of Proficiency** – 23-25 credit hours of required geospatial-science courses.

Each degree program, with the exception of the Geology BA, has a designated **capstone** course in which the students are expected to apply the knowledge and methods learned in previous courses in authentic, scenario-based projects or student teaching. The capstone course for geology (BS) majors is GEO 4510 – Geology Field Camp. Our field camp is different from traditional field camps in that we use a combination of local projects, students spend their evenings at home, and remote projects, where the students are camping during a multi-day assignment. This format has allowed us to keep the cost and duration (4 weeks) of summer field camp in check, which has greatly benefited our non-traditional majors (working, married, with children). We offer field camp every other summer, in a cooperative effort with the Department of Geosciences at Utah State University (Logan, UT). GEO 4060, Geoscience Field Methods, functions as the capstone course for the applied environmental geosciences (BS) majors. It emphasizes the collection and analysis of field data for a variety of geoscience applications and culminates with a group project that models a geologic-hazards site assessment. Earth Science Teaching majors typically spend their last semester prior to graduation student teaching in a local school, for which they receive academic credit (EDUC 4940 & 4950); this is a very authentic and demanding capstone experience.

3.2 Types of Minors Offered:

The Department of Earth and Environmental Sciences offers 3 minors:

• **Geology Minor** – 19 credit hours of required geoscience courses.
• **Geospatial Studies Minor** – 18 credit hours of required geospatial-science courses.
• **Earth Science Teaching Minor** -- 20 credit hours of required Earth science courses.

The three minors listed above may be also used as one of the three required emphasis areas for students pursuing a Bachelor of Integrated Studies (BIS).

3.3 Curricular Changes Since Last Program Review (2012):

Since 2014, the geoscience community in the United States has been engaged in a comprehensive evaluation, sponsored by the National Science Foundation, of the future of undergraduate geoscience education (http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/). The Department of Earth and Environmental Sciences participated in both the 2014 and 2016 academic summits hosted by the

University of Texas at Austin and was committed to using the results of this national effort to evaluate and revise its courses and curricula to better prepare our students. One of the most import aspects of this national-level work is the fact that geoscience employers, from all sectors, were engaged in the process and the community now has a broad consensus on the content knowledge and skills that 21st-century geoscientists will need to be successful in the geoscience workforce and/or geoscience graduate programs (MS or PhD). In addition, in October 2017, our department hosted a 2-day workshop sponsored by the National Association of Geoscience Teachers (NAGT) that brought 2 outside facilitators to help us finalize new curricular emphases and to integrate sustainability science concepts across our revised curricula.

Appendix J contains a bibliography of educational research and commentary that was reviewed and discussed as part of our curriculum revision.

The Department finalized curricular changes in Fall 2018 and they worked their way through the University's approval process during Spring 2019. The changes listed below, effective Fall 2019, represent a deliberate shift in both the Geology and Applied Environmental Geosciences degrees toward more emphasis on applied and environmental geoscience, which in turn will support the future job placement of geoscience graduates in the environmental and/or resource management sector of STEM-related jobs:

• GEO 3000 (Geoscience Methods & Careers, 3 cr hr) is a new course that is now required to help students transition from lower-division survey courses to upper-division courses involving field work and data analysis, develop workforce ("soft," "transferable," "essential") skills, and plan for professional licensure exams. We refer to this course as the "sophomore bridge" class.

• GEO 3080 (Applied Hydrology, 4 cr hr) is now a required course, reflecting the importance of water science to environmental consulting firms and working geoscientists.

• GEO 4560 (Environmental Geochemistry, 4 cr hr) is a new course that is now required, reflecting the importance of geochemical data and processes in understanding a wide variety of environmental issues. In the Geology degree, this course replaces the previously required GEO 4300 (Igneous and Metamorphic Petrology, 4 cr hr).

• GEO 4990 (Geoscience and Society Seminar, 2 cr hr) is a new senior seminar that will use case studies to show the application of geoscience principles and methods to real-world problem solving. The course will also help students connect their previous course work to the skills desired by graduate programs and employers.

• The previous Geology program had 2 options, A (Minor required) and B (no minor required). This revised program will not require a minor. Over the years, very few Geology majors completed a minor program of study. A minor has never been required for the Applied Environmental Geoscience degree.

• The total number of credit hours in geoscience courses increased in both the Geology and Applied Environmental Geosciences degrees. This increase was partially offset by a reduction in the required geoscience elective and/or cognate science credits. We think this increase is justified because the new curricula are better aligned to the essential content knowledge and science skills identified by *The Future of Undergraduate Geoscience Education* Project (NSF 2014, 2016).

3.3.1 Departmental Name Change in 2018: In junction with the curricular changes described above, the former Department of Geosciences became the **Department of Earth and Environmental Sciences (EES**). Our rationale for the name change was based on the following:

(1) We have offered the Applied Environmental Geosciences (AEG) degree since 1996 and many of our recent graduates (both Geology and AEG) have sought and found employment in the environmental science sector of STEM careers (see section 8.3). Thus, we feel the new department name better represents the career goals of current and future majors.

(2) The EES name will help students identify educational opportunities in the College of Science related to environmental issues and the Earth sciences. At present, most geoscience students are "found majors," recruited from general education courses. Most high schools do not offer a course in geology or geoscience, though some students take a 9th-grade Earth Science course. We therefore suffer from poor name recognition. Many incoming students, however, have at least heard of Earth Science, and some may have taken an AP Environmental Science course grounded in Earth System science. The name change will help students find courses, and possible majors, related to their high school experiences and interests in the environmental field.

(3) A quick Google search reveals that many former departments of Geology have changed their name to Earth and Environmental Sciences, which better represents the future of our evolving discipline. Many EES departments also participate in a cross-disciplinary Environmental Science BS program. At WSU, EES faculty are presently working with colleagues from every department in the College of Science to develop a new Environmental Science BS, which will leverage the energy and expertise that recent hires in the College of Science have brought to WSU.

4. STUDENT LEARNING OUTCOMES AND ASSESSMENT

4.1 Measurable Program-Level Learning Outcomes:

At the end of their program of study in the Department of Earth and Environmental Sciences, our graduates will have a set of basic intellectual skills that they can apply to a variety of situations and will have a knowledge and understanding of core concepts in the Earth sciences.

• BASIC SKILLS – EES graduates will:

1. be able to collect data, apply algebraic and graphical techniques to analyze data, and interpret results. **{Problem-Solving Skills}**

2. be able to clearly express geoscience concepts orally and in writing, present results from laboratory and field investigations, and effectively incorporate appropriate maps and graphs into presentations and reports. **{Communication Skills}**

3. be proficient in the use of appropriate technologies – including basic computer skills (word processing, spread sheets), geospatial skills (GPS, accessing geospatial databases), and information-literacy skills (searching, compiling, and evaluating information from scientific literature and web resources). **{Computer & Information-Literacy Skills}**

• EARTH SCIENCE SKILLS – EES graduates will:

4. be able to identify common minerals and rocks, describe rock characteristics, and interpret the environments/conditions (igneous, sedimentary, or metamorphic) in which rocks formed. **{Earth Materials}**

5. be able to identify major physical and biological events in Earth history and describe the methods used to interpret this history, including radiometric dating, fossil succession, and stratigraphic correlation. **{Earth History}**

6. be able to identify landforms from maps and imagery, construct topographic profiles, and interpret the development of landforms in terms of common surface processes. **{Surface Processes}**

7. have a general understanding of plate tectonics (plate motions, plate boundaries, and types of tectonic activity), and be able to analyze/interpret basic structural relations from geologic map data and cross sections. **{Tectonic Processes}**

8. be able to describe key geological cycles – including the hydrologic cycle, rock cycle, and carbon cycle. **{Earth Systems}**

9. have demonstrated an understanding of scientific methodology and the interdisciplinary nature of the geosciences, culminating in a capstone experience involving collection and analysis of multiple data sets to interpret Earth processes. **{Capstone Experience}**

Our nine (9) program-level learning outcomes (PLOs) are mapped to specific required courses (see Table 1: Curriculum Map), and direct measures of student learning from key courses are evaluated and documented as part of the biennial (formerly annual) assessment report submitted to the Office of Institutional Effectiveness (see section 4.4). The PLOs were the focus of 2014-2015 assessment report (no major curricular or

TABLE 1: Curriculum Map

Core Courses in the EES Department	Department Learning Outcomes (DLOs)								
	LO 1: Problem-solving Skills	LO 2: Communication Skills	LO 3: Computer & Information Literacy	LO 4: Earth Materials	LO 5: Earth History	LO 6: Surface Processes	LO 7: Tectonic Processes	LO 8: Earth Systems	LO 9: Capstone
GEO 1110 Dynamic Earth: Physical Geology	I	I		I	I	I	I, A	I	
GEO 1115 Physical Geology Lab	I			E		I	I		
GEO 1220 Historical Geology	I	I	I		E, A		R	E, A	I
GEO 2050 Earth Materials		I	I	E, A					
GEO 3150 Geomorphology	R	E	I	R	R	E, A	R	R	I
GEO 3550 Sedimentology & Stratigraphy	E	E, A	R	E	R		R	R	I
GEO 3710 Introduction to GIS	R	R	E, A						
GEO 4060 Geoscience Field Methods	E, A	R	R	R	R	R	R, A		E, A
GEO 4510 Geology Field Camp	R	R	R	R	R	R	R		E, A
GEO 4560 Environmental Geochemistry	E, A	E, A	E	R				E, A	

Note: I = introduced; E = emphasized; R = reinforced; A = comprehensively assessed

pedagogic changes were needed), and will be the focus of an assessment report to be submitted in November 2022.

A significant indirect measure of the PLOs is the results from the **exit interviews** that we routinely conduct with all graduating seniors. During the interviews the graduates are asked about their satisfaction with college- and department-level advising and their perceptions of the strengths and weaknesses of our programs. In addition, they are asked to self-report, using a Likert-type scale, on their level of mastery of the nine (9) PLOs. The averages (2012-2019) for the individual learning outcomes range from a low of 4.01(PLO #5: Earth History) to a high of 4.46 (PLO #8: Earth Systems). Overall, these data support the direct measures of student learning from course-level assessments.

4.2 General Education:
The Department of Earth and Environmental Sciences supports the General Education Program at Weber State University by offering five (5) courses, each are 3 credit hours, that may be used to satisfy the Physical Science (PS) breadth requirement for graduation:

- GEO 1030 PS Earthquakes and Volcanoes
- GEO 1060 PS Environmental Geoscience
- GEO 1110 PS Dynamic Earth: Physical Geology
- GEO 1130 PS Introduction to Meteorology
- GEO 1350 PS Principles of Earth Science (geology & meteorology for Elementary Ed. majors)

The curriculum for each of these courses is informed by, and conforms to, geoscience-community standards, as expressed in (1) various national literacy documents (e.g. *Earth Science Literacy Principles* http://www.earthscienceliteracy.org/document.html and *Atmospheric Science Literacy Framework* https://scied.ucar.edu/atmospheric-science-literacy-framework); (2) annual inter-departmental discussions mandated by the Utah System of Higher Education (USHE) ("Geology Major Meeting"); and (3) content of nationally marketed introductory textbooks.

Three of the department's general education classes (GEO 1030, GEO 1060, and GEO 1110) are regularly offered in an online format through ***WSU Online***, a comprehensive distance-learning program managed by the Division of Continuing Education. Typically, our online offerings reach maximum enrollment early in the registration period.

4.2.1 Support of the General Education Improvement and Assessment Committee:
Rick Ford and Carie Frantz participated in the campus-wide General Education Revitalization project (2017-2019), which was developed and implemented by the university-level "Gen Ed" committee (GEIAC). They were early adopters of the new Big Question (BQ) and Signature Assignment (SA) components of general education courses. Later, EES faculty organized and participated in departmental-level meetings in April and August 2019 to brainstorm and share ideas for geoscience-related BQs and SAs. The Department was ready when the new general education requirements took effect for Fall semester 2019.

4.3 Concurrent Enrollment and Davis Campus Courses:

As a department, we strongly support the University's ACCESS theme/priority. The Department of Earth and Environmental Sciences has long partnered with the Division of Continuing Education to offer evening classes at the university's Davis Campus. The general education courses offered at this location are taken by wide variety of non-traditional students wishing to fulfill the physical science (PS) breadth requirement. Our partnership with Continuing Education has permitted us to offer evening courses on the main Ogden campus as well. In addition, Amanda Gentry, one of our adjunct instructors, has become experienced in the use of interactive video conferencing (IVC) to offer courses at small remote sites, such Morgan, Roy, and Farmington, Utah.

Beginning in 2016, we have supported current enrollment sections of *Dynamic Earth: Physical Geology* (GEO 1110 PS), first at Weber Innovation High School (Weber School District), and then in 2017 at Utah Military Academy (Ogden). This academic year (2018-2019) the Northern Utah Academy for Math, Engineering, and Science (NUAMES) opened a new location on WSU's main campus in Ogden; previously NUAMES had been solely located on WSU's Davis Campus. We used funds from Liz Balgord's GETUP grant (see Sec. 2.2) to offer a concurrent enrollment section of GEO 1110 for this new partnership between WSU and NUAMES. We are very excited about this partnership, as NUAMES brings motivated college-bound students interested in STEM to our campus. We see concurrent enrollment courses for this student body as significant recruitment opportunities for the College of Science and our department. The Fall 2019 class was so successful that NUAMES has asked us to offer two sections (60 students total) during Spring 2020. We are also beginning to look at the possibility of offering a concurrent enrollment course in partnership with the Davis School District.

4.4 Five-year Assessment Summary

Prior to 2019, all WSU academic departments were required to submit an annual assessment report to the Office of Institutional Effectiveness. Beginning in 2019, this report will be submitted every other year. Our 2020 report will focus on assessment data from the department's general education courses and key high-impact educational experiences (HIEEs), such as summer field camp, internships, and study abroad programs. The 2022 report will focus program-level learning outcomes (PLOs).

The Department's assessment report for academic year 2014-2015 focused on our program-level learning outcomes (PLOs) (see section 4.1). Direct measures and exit interviews indicated that EES graduates were meeting the PLOs and attaining geoscience competencies at an appropriate level. The 2015-2016 report focused on HIEEs. In evaluating the data reported, we realized that the AAC&U *VALUE* rubrics for critical thinking and problem solving would be useful in assessing the final projects that students complete as part to the capstone summer field camp (GEO 4510). The 2015-2016 report also highlighted the need for a dedicated assessment instrument, comparable to student course evaluations, for internships, undergraduate research, and study abroad programs. Unfortunately, no progress has since been made in identifying or creating such assessment tools. The 2016-2017 assessment report focused on the physical science intended learning outcomes (ILOs) for the Department's general education courses and concluded that students in those courses were meeting the learning outcomes at an appropriate level. No major curricular or pedagogic changes were needed at that time, though faculty committed to minor changes in pedagogic strategies to improve outcomes for specific ILOs. The 2017-2018 report was

a short response to questions from the Office of Institutional Effectiveness related to implementation of the general education Big Questions and Signature Assignments and to the job and graduate-school placement of recent graduates (see section 8.3).

4.4.1 Graduate Success in Passing State Licensing Examination: All geologists working in Utah whose work is relevant to public welfare or safeguarding life, health, property, or the environment are required to obtain the Professional Geologist license from the Division of Occupational and Professional Licensing. To qualify for this license, geologists must pass two (2) national examinations administered by the National Association of State Boards of Geology (ASBOG): (1) the **Fundamentals of Geology (FG) exam** is typically taken during a student's senior year; and (2) the Principles and Practice of Geology (PG) exam, which can be taken after 5 years of relevant work experience under the supervision of a licensed geologist. In 2018 the Department received a *Curriculum Assessment Performance Tool* (CPAT) report from ASBOG that provided detailed information about the performance of WSU geoscience graduates on the FG exam. The data on the performance of our students related to specific content domains of the exam (e.g., mineralogy and petrology, hydrogeology, engineering geology) provided another direct measure of our graduates' mastery of our program level-learning outcomes (PLOs). We were very pleased to learn that our graduates had a 93% pass rate (14 out of 15) over the period from 1990 to 2016.

5. ACADEMIC ADVISING

5.1 Advising Strategy and Process:

Students declaring a major in the Department of Earth and Environmental Sciences have an initial meeting with the department chair to discuss educational goals and to review the various degree programs offered by the department. A separate file is created for each major, minor, or BIS student, and is updated until graduation; these files are also maintained after graduation {BIS= Bachelor of Integrated Studies, a program wherein students select 3 emphasis areas; a geology emphasis is an option}. The department secretary works with the chair to "declare" the student's major within *CatTracks*, the University's e-transcript and degree-evaluation platform. Students are also assigned to different advisors depending on their major/minor: Geology (BA/BS) and Earth Science Teaching -- Rick Ford; Applied Environmental Geosciences – Marek Matyjasik; and Geospatial Studies Minor and Geospatial Analysis Certificate of Proficiency – Michael Hernandez. Most students meet with their advisor at least once a year to check progress and to develop a program of study for each semester or academic year until graduation. Future course offerings (3-year plan) are regularly updated and posted for students to use in general planning. Students are also encouraged to meet with other faculty to discuss areas of interest and potential career paths. All faculty work with students to obtain internships and admittance to graduate programs, and regularly write letters of recommendation. The department chair also sets up meetings with graduating seniors, either early in the semester of graduation or the semester before, to double check the student's graduation evaluation ("sign off") and to conduct an exit interview. Additionally, students may meet with the College of Science Academic Advisor for advice on general education courses and other university graduation requirements. Students are also encouraged to utilize the wide variety of resources available in the office of Career Services.

In an effort to foster effective communication between faculty and student majors, we have published a weekly departmental **eNewsletter** since 2012. Ours was the first departmental newsletter in the College of Science, and one of the first on campus, and now has a subscriber list of 710 students, alumni, and friends of the department. The newsletter, managed by Marianne Bischoff, our creative and multi-talented administrative specialist, provides information about internships, jobs, scholarships, guest speakers, course offerings, volunteer opportunities, club activities, and academic advising. Its purpose is to support student success. In response to a concern raised during our last program review (2012-2013) about the lack of early advising for new majors, we started holding a department **"Town Hall Meeting"** at the beginning of Fall semester. The audience is primarily first- and second-year students and all faculty and staff attend. The agenda for each town hall includes a heavy dose of basic advising (e.g., "delay math, delay graduation"), short statements from each faculty member about UR and internship opportunities, and information from the officers of our student clubs. EES students are also strongly encouraged to meet regularly with their academic advisor. We also work with the academic advisor for the College of Science to assist students with timely completion of their general education requirements and with transfer and course articulation issues. Lastly, WSU has recently begun campus-wide use of ***Starfish***, a technology tool that supports student success by facilitating targeted communication between students, course instructors, academic advisors, and student-support services. As part *Starfish* implementation, the administration provided funds for an additional academic advisor in each college, who would be focused on improving student retention. We are committed to effective coordination and communication between our department-level advisors and the college-level advisors and to utilizing the *Starfish* student-success tool to the best of our ability.

5.2 Effectiveness of Advising:

We collect information about advising effectiveness by asking questions on the frequency and quality of advising during exit interviews with graduating seniors. These exit interviews indicate that graduates met regularly (at least annually) with a department advisor, were very satisfied overall with the quality of the advising they received, and that misadvising is not an issue within our programs.

5.3 Past Changes and Future Recommendations:

The department's advising system has evolved since our last program review (2012-2013) from a decentralized system, where every faculty member was involved in advising, to a more centralized system where only 3 of the department's faculty are formally advising majors. This approach was taken in response to the rapid growth in majors and the retirement of senior faculty, to aid in consistent messaging, and to leverage an economy of scale with respect to faculty time. Going forward, we plan to centralize departmental advising even further. Rick Ford will be stepping down as department chair at the end of this academic year and has agreed to be the primary advisor for the new inter-departmental Environmental Science degree and he may become the primary advisor for all EES degrees and minors, with the exception of the geospatial certificate and minor, for which Michael Hernandez will continue to advise.

6. FACULTY

The department currently has nine (9) tenured or tenure-track ("regular"/8.25 FTE) faculty, and five (5) adjunct instructors that teach part time on a regular basis, with a combined full-time equivalent (FTE) that has varied from 8.1 to 8.6 over the last 5 years (Appendix A). Seven of the regular faculty have full-time appointments within the Department of Earth and Environmental Sciences. David Matty, former Dean of the College of Science (2011-2018), has a 0.75-FTE appointment in the department and a 0.25-FTE appointment with the Office of Sponsored Projects. (The administration has informed the department that should Dr. Matty leave the university, his faculty line will revert to the Provost's Office.) Ryan Frazier has a joint appointment (50/50) between EES and the Department of Geography (College of Social and Behavioral Sciences). The five full professors are a senior group, with a combined 122 years of teaching experience (Appendix B). Curriculum vitae of the regular faculty are available on the Program Review website.

There likely will be one or more retirements within the next 5 years for which the department will need to plan. The retirements on the horizon will provide the department an opportunity to examine the possibility of new directions and sub-disciplinary specialties, with the goal of improving our various degree programs and better preparing our graduates to live, work, and learn in the 21st century. As a department, we are just beginning to have discussions about potential future directions, but we know we must plan for a future that will be substantially different from our present circumstances.

6.1 Departmental Teaching Standards:

Teaching standards are determined by three sources: (1) the University's Peer Review policies and procedures, (2) the Annual Review policies and procedures of the College of Science; and (3) the College and University Rank and Tenure policies and procedures. For additional details on these, see Section 6.3 below. These standards are communicated to the faculty by the Department Chair, Dean, and other key academic administrators of the university such as the Associate Provost and Provost. New faculty are also given orientations during the annual campus-wide New Faculty Retreat. New faculty members also undergo informal second-year reviews by the chair.

6.2 Faculty Qualifications:

All nine regular faculty members hold a PhD in the Earth or geospatial sciences and five of the nine have earned tenure within the College of Science (Appendix B). The sub-disciplinary expertise of the regular faculty covers most of the major areas of traditional geology and applied geoscience, including sedimentology, stratigraphy, geochemistry, environmental geology, hydrogeology, oceanography, geomorphology, GIS, remote sensing, geologic hazards, mineralogy & petrology, structural geology, and tectonics. Paleontology is the major sub-disciplinary area not covered by the present members of the faculty. Some of the regular faculty also have significant industry and/or governmental agency experience, as well as being licensed professional geologists (P.G.) in the state of Utah. All of the adjunct instructors have an advanced degree in the geosciences, along with extensive classroom experience.

Several EES faculty have been recently recognized by their peers and the university administration for the overall excellence of their teaching, scholarship, and service. Adolph

Yonkee is a member of the select group of Brady Presidential Distinguished Professors, possibly the highest award a WSU faculty member can achieve, and was the 2019 recipient of the John S. Hinckley Fellow Award. Adolph was also elected a Society Fellow of the Geological Society of America in 2019. In 2018, Carie Frantz received an inaugural Presidential Teaching Excellence Award. Marek Matyjasik is on sabbatical leave for Spring 2020, having been awarded a Fulbright Fellowship to teach at Warsaw University in Poland.

6.3 Faculty Scholarship:

The faculty of the Department of Earth and Environmental Sciences are active scholars, and most have been either the lead author or a co-author on a publication since 2015. EES faculty regularly present the results from ongoing research at major geoscience conferences, notably, the annual meetings of the Geological Society of America and the American Geophysical Union. (Short CVs of the EES faculty are available on the program-review website.). Several faculty members are among the most productive researchers on campus and most have been very effective in incorporating undergraduate researchers in to their respective research programs (see sections 2.3 and 6.7.3, and Appendix H).

Many EES faculty have been very successful in writing and securing external grants to fund their research. In 2018, when we were still a 6-person department, there were five (5) active NSF grants overseen by EES faculty. Department chair Rick Ford was the lone slacker. The major recent, and on-going, external grants are listed below; this is <u>not</u> an exhaustive list:

• National Science Foundation GP EXTRA: *Geoscience Education Targeting Underrepresented Populations (GETUP).* Co-PIs: Liz Balgord, Marek Matyjasik and Carie Frantz (2018-present).

• Utah System of Higher Education StepUP Grant: *Increased Recruitment and Retention of underrepresented Groups in STEM Fields Using a Combination of Geoscience Concurrent Enrollment and Summer Bridge Program*. Co-PIs: Liz Balgord and Marek Matyjasik (2016-2017).

• NSF Division of Earth Sciences/Sedimentary Geology & Paleobiology: Collaborative Research: *Assessing the sensitivity of high-altitude environments to globally warm climate as recorded by lacustrine microbialite carbonates*. Co-PIs: Carie Frantz and non-WSU collaborators (2018-2021).

• NSF Advanced Technology Education (ATE) Grant: *Developing a Vision and Plan for the Northern Utah Geospatial Technology Education Program (NUGTEP)*. Co-PIs: Michael Hernandez and Eric Ewert (Geography) (2013-2019).

• USDA Forest Service (FIA) – Joint agreement with WSU (2nd renewal)**:** *Effects of historic forest disturbance on water quality and flow in the Interior Western US*. PI: Marek Matyjasik. Co-PI: Michael Hernandez (2013 – present).

• NSF Collaborative Research: *Characterizing the regional fluid flow system of the Wyoming salient, Sevier fold-thrust belt: Implications for orogenic wedge deformation and propagation*. Co-PIs : Adolph Yonkee, Gautam Mitra [University of Rochester] and Mark Evans (Central Connecticut) (2015-present).

• NSF Collaborative Research: *Interrelations between foreland deformation, flat-slab subduction, and crustal architecture, south-central Andes*. Co-PI s: Adolph Yonkee and Arlo Weil (Bryn Mawr College) (2014-present).

6.4 Mentoring Activities:
Regular faculty members, in consultation with the department chair, set mission-related goals for the next academic year and evaluate goals from the previous year during a spring semester meeting. The department chair undergoes a similar mentoring/review process in consultation with the dean. Teaching assignments are made by consultation between the chair and faculty, with a normal teaching load of 24 TCH per academic year. The chair goes over the student teaching evaluations each semester with faculty and adjuncts to identify strengths and weaknesses. The department provides funds for professional development and travel (generally one conference or workshop per year), with additional funds available through the Research, Scholarship, and Professional Growth Committee (internal grants), and from external grants. Faculty can also apply for a sabbatical leave, subject to administrative approval. During the past 5 year only one faculty member, Adolph Yonkee took a 1-semester sabbatical, with his teaching assignments covered internally. We are anticipating and planning for one member of our faculty to be on sabbatical during both the Fall 2020 and Spring 2021 semesters.

After a long period of no change within the faculty, the Department of Earth and Environmental Sciences has been fortunate in the hiring of four assistant professors since 2015. The department chair has primary responsibility to make a new faculty member aware of the Policies and Procedures Manual, College of Science tenure expectations, opportunities for university-sponsored training and workshops, and external workshops related to pedagogy and early-career planning. We are a collaborative, collegial group and quite a bit of informal mentoring takes place, including the sharing of course materials and pedagogic strategies as any instructor, new or experienced, is faced with a new course prep.

6.5 Diversity of Faculty:
At the time of our last program review (2012-2013), all 6 regular faculty members were white males, and 3 of the 4 adjunct instructors were white males. In Fall 2019, after replacing retired faculty and growing to 9 regular faculty, 6 regular faculty are white males and 3 regular faculty are white females (Appendix B). Four of the 5 active adjunct instructors are white females and one is a white male. Progress has been made on gender diversity, but we struggle, as most geoscience departments do, to diversify with respect to ethnicity.

6.6 Ongoing Review and Professional Development:
Regular faculty members are evaluated in teaching, research, and service each year by the department chair as part of a standardized, college-wide, annual review process. This process includes the setting of specific mission-related goals for the upcoming academic year. Results from these annual reports are then reviewed by the Dean, in consultation with the department chair. Annual faculty reviews indicate frequent lab improvements, course updates, use of new pedagogic techniques, attendance of pedagogically focused workshops, and obtaining grants for instructional improvement.

Standardized student evaluations are given in at least two courses per year for each regular faculty member -- in practice almost all courses taught by regular faculty undergo student evaluation. Student evaluations are conducted in all courses taught by adjunct instructors. The department chair reviews and discusses the numerical results from the evaluations, and students' written comments, with each instructor. The faculty and adjunct instructors in turn use this feedback to help improve pedagogy, content, and assessment methods.

The department encourages faculty to attend workshops related to geoscience pedagogy and provides travel funds for those who participate. In the past five years EES faculty have participated in AAC&U workshops focused on STEM transformation and active-learning pedagogies, an UAVs/drones in education workshop, an NAGT Traveling Workshop on incorporating sustainability across the curriculum, and numerous pedagogy-related webinars. Collectively, we share strive to stay abreast of advances in geoscience pedagogy and to collaborate and share teaching materials, strategies, and classroom activities.

6.7 Use and Effectiveness of High-Impact Educational Experiences:
The Department of Earth and Environmental Science offers its students a number of high-impact educational experiences (HIEEs), including single- and multi-day course-specific field trips, undergraduate research, capstone courses and projects, collaborative assignments and projects, study abroad, and internships. Within the extracurricular realm, the Department also encourages and supports our students' many service-learning and community-outreach projects sponsored by the Geology Club and Sigma Gamma Epsilon (national Earth science professional/ honor society). Some of the comments below are repeated from Section 2.3.

6.7.1 Capstone Courses: Each degree program, with the exception of the Geology BA, has a designated capstone course in which the students are expected to apply the knowledge learned and skills developed in previous courses in applied, scenario-based projects or student teaching. Applied Environmental Geoscience majors are required to complete GEO 4060 (*Geoscience Field Methods*) and Earth Science Teaching majors spend their final semester in "student teaching" (EDUC 4940/4950). Geology majors are required to complete summer *Geology Field Camp* (GEO 4510) during the first block of summer term. **"Field Camp"** is a widely utilized capstone experience for the training of geoscientists in the United States. The Department of Geosciences has traditionally offered its field camp course during alternate summers in a collaborative effort with the Department of Geosciences at Utah State University. Course description for GEO 4510:

Integrated approach to collecting field data and interpreting geologic processes and history. Includes geologic mapping and analysis of bedrock, surficial deposits, geologic structures using aerial photographs, topographic maps, and surveying techniques. Results presented in written reports, maps, and graphical formats. About forty hours of lab per week for about 4 weeks. (4 credit hours)

Two projects in GEO 4510 (Summer Term 2016) were used to assess this capstone course as a high-impact educational practice:

Project 1. Analysis of Absaroka thrust fault and Little Muddy Creek Conglomerate in southern Wyoming. This project required students to integrate geologic mapping, measurement and geometric analyses of structural features, and measurement of stratigraphic section with clast

counts. The final product was a written report, with graphical representations of the various data sets, and interpretation of geologic history.

Project 2. Analysis of Wasatch fault and related geologic hazards near Willard, UT. This project required students to integrate geologic mapping, measurement of fault scarps, and measurement of alluvial-fan characteristics, again leading to a final written report – this time focused on geologic-hazard identification/documentation and Quaternary geologic history.

The instructors used three (3) of the *VALUE* rubrics developed by the AAC&U to assess student learning during the two projects: (1) Inquiry and Analysis; (2) Problem Solving; and (3) Written Communication {*VALUE* = Valid Assessment of Learning in Undergraduate Education}. In addition, two geoscience-specific rubrics were used to assess the students' ability to accurately and appropriately integrate geoscience concepts into their final report. Each rubric is organized around a rating scale from 1 (Benchmark) to 4 (Capstone).

These projects are challenging capstone assignments with demanding expectations, as they require students to use many skills and integrate multiple fields of knowledge. The assessment data indicated the 2016 students performed at "milestone" levels (2 or 3 on the 4-point scale). However, the instructors noted that some students had difficulty organizing their final report in such a way as to integrate all the aspects that were requested in the project. "Writing for the geosciences" is now a point of emphasis in our department and we will continue to look for methods and practices that we can share with our students to improve their writing skills. To this end, Adolph Yonkee has developed a new course (see section 3.3), *Geoscience Methods & Careers* (GEO 4750), that includes several modules focused on developing the students' scientific-writing skills. Going forward, we will expand the use the *VALUE* rubrics to assess student learning in our *Geoscience Field Methods* course (GEO 4060), which is the capstone course for the Applied Environmental Geoscience major.

6.7.2 Internships: Over the years, a good number of our students have participated in geoscience-related internships, both paid and unpaid, with local companies and governmental agencies. Students are able to receive academic credit for these experiences through our *Cooperative Work Experience* course (GEO 4890). Unfortunately, we have not collected systematic assessment data for past internships. We need to institute data-collection procedures to track and document the internships completed by departmental majors. We will also work with the Office of Institutional Effectiveness (OIE) to identify an appropriate assessment instrument and/or student evaluation for these high-impact experiences.

6.7.3 Undergraduate Research: The Department of Earth and Environmental Sciences has a long history of supporting undergraduate research, even before it received the institutional support and recognition that it now enjoys on our campus; undergraduate research is an important part of our departmental culture. In the past five years, approximately 120 students (students were counted more than once if they participated in multiple UR projects) associated with the Department of Earth and Environmental Sciences (majors, minors, and microbiology students working with Carie Frantz) participated in 14 faculty-guided undergraduate research projects, resulting in approximately 40 presentations at national or regional scientific conferences and/or the annual WSU UR Symposium (see Section 6.7.3 and Appendix H). Appendix H lists and

summarizes the extensive efforts that EES faculty have made in support of undergraduate research. However, in terms of assessment data related to student learning and skill development, the situation here is similar to that for internships; we need an assessment plan and a student evaluation instrument focused on undergraduate research. In addition, we plan to increase the level of participation in UR by our majors. With a small faculty, we think the best way to do this is through the use of course-based undergraduate research experiences (CUREs). Carie Frantz has become a campus leader in the use of CUREs in her interdisciplinary upper-division courses (*Geomicrobiology* GEO/MICR 3753 and *Geochemistry* GEO/CHEM 4550). With our recent curriculum revisions (see section 5.3), these courses are now required for Geology and AEG majors, thereby significantly increasing the number of geoscience majors who will have the opportunity to participate in a high-impact undergraduate-research experience.

6.7.4 Global Learning/Study Aboard: Although this type of experience is not routinely offered by the Department of earth and Environmental Sciences, on occasion faculty have planned and executed substantial geoscience-related travel experiences through WSU Study Abroad Office. Most recently, the Marek Matyjasik and Liz Balgord organized and led student trip to Iceland during Summer Term 2019. Marek Matyjasik also led separate trips to Hawaii and Iceland in 2015. As with UR and internships, we do not have assessment data for these experiences beyond the basic course evaluations that students completed at the end of the term. We need to work with the Study Abroad Office and the Office of Institutional Effectiveness to identify an appropriate assessment instrument and/or student evaluation for study-abroad experiences.

6.7.5 Support for Student Organizations: The Department of Geosciences hosts two vibrant student organization that play an important role in our retention and student-success efforts. For as long as anyone can remember, geoscience majors have been involved in social and professional enrichment activities under the guise of the Geology Club. Since 1998 the department has also sponsored a chapter of Sigma Gamma Epsilon (SGE), the national academic honor society for geoscience majors and minors. SGE sponsors a number of professional-development activities, and both organizations support the University's COMMUNITY theme through science outreach and service projects. For the past several years our SGE chapter has earned Quality Chapter and Outstanding Service Awards from the national organization.

6.8 Evidence of Effective Instruction:

6.8.1 Regular Faculty: There are several kinds of systematic evaluations of full-time, tenure-track faculty used by the department, college, and university:

• Annual Reviews (year-end reports) conducted of all faculty by the department chair using data provided by faculty members pertaining to teaching, scholarship and service and evaluated according to established College of Science procedures with the results reported to the College Dean (see section 6.6);

• Second-Year Reviews of new tenure-track faculty made by the department chair according to university policy, with the results submitted to the faculty professional files;

• Peer Reviews of all faculty conducted by an elected departmental Peer Review Committee, which evaluate course-related materials submitted by the faculty member under review and include classroom, laboratory, and field teaching observations. These reviews occur as part of the evaluation process for tenure and promotion, with the results submitted to the faculty professional files in the department and College;

• Ranking and Tenure Reviews, conducted by the appropriate committees as prescribed by University policy, that evaluate effectiveness in teaching, scholarship and service, with the results maintained in faculty professional files;

• Student Evaluations of faculty and classes conducted formally in accordance with College and institutional policies and procedures using a standardized instrument; and

• Post-Tenure Review conducted every five years following the awarding of tenure. Faculty submit a brief summary of their past 5 annual reports to the department chair, and the chair evaluates the summary and forwards an evaluation (satisfactory/unsatisfactory) to the dean.

The data/results from these various reviews and evaluation of teaching effectiveness are to the individual faculty member and kept on file by the appropriate administrators. Often data obtained from one form of evaluation are used within other evaluations (e.g., Peer Review and Student Evaluation data are used for purposes of merit, tenure, and ranking reviews). This rigorous review process has kept faculty and administrators informed of institutional expectations and the caliber of their performance in comparison with these expectations. Despite many faculty and department chairs commenting on "report and evaluation fatigue," feedback from this array of evaluations has enabled and motivated faculty to improve their teaching, research, and service over the years. This, in turn, has led to positive outcomes with respect to retention and tenure, promotion, merit pay, and sabbatical leaves.

6.8.2 Adjunct Faculty: There are two kinds of systematic evaluations of part-time, adjunct faculty used in the department:

• Student Evaluations for every course taught, conducted formally in accordance with College and institutional policies and procedures using a standardized instrument.

• Classroom observations periodically/irregularly conducted, due to time constraints, by the department chair.

7. Support Staff, Administration, Facilities, Equipment, and Library

7.1 Adequacy of Staff:

The Department has adequate office-management support in the form of a three-quarter-time (0.75 FTE) administrative specialist (Appendix C). Marianne Bischoff was hired in 2012 and has provided excellent administrative support to the faculty and students. In addition, her work on the department's eNewsletter and support of the department's advising efforts have contributed

directly to student retention and success. Marianne's contributions and quality of work were recognized by her peers in the form of the 2015 Super Staff Award and again in 2017 as the recipient of the Presidential Outstanding Staff Award.

At the time of our last program review (2012-2013), EES was the only department in the College of Science, other than Mathematics, that did not have a lab manager. That program review, as well as every program review for the previous 15+ years, strongly recommended the addition of such a position to the department's staff. In 2018, we were given the opportunity to make our case for such a position, in the form of a departmental strategic plan, directly to the Provost's Office. The provost agreed to fund a geoscience lab manager and instructor position (fulltime, 10 months) and our first lab manager, Sara Summers (WSU '10), began work in January 2019. In addition to her lab manager duties, Sara Summers also teaches introductory labs and the occasional general education course. We are still experimenting with her specific work assignments to find the best model in terms of providing broad support for the department's students and faculty.

The faculty of the Department of Earth and Environmental Sciences think the most pressing staff-related issue facing the whole College of Science, not just our department, is the need for a **college-level lab/instrument technician**, as the college continues to upgrade its analytical capabilities through the acquisition of high-end equipment, such as the ICP-OES and ICP-MS. This equipment is shared among the various departments and requires a substantial commitment of time and resources to basic operations and maintenance. Such a position could act to support the analytical needs of all the departments in the college, and would be a key resource for students wishing to use the equipment for undergraduate research.

7.1.1 Ongoing Staff Development: The administrative specialist and lab manger, in consultation with the department chair, set performance goals using the university's Performance Review and Enrichment Program (PREP). They are both evaluated annually by the chair using PREP, which reviews performance of basic job functions and addresses how well goals from the previous year were met. Throughout the academic year, the administrative specialist and lab manager/instructor are encouraged to attend professional development classes/seminars given by the university. Both Marianne Bischoff and Sara Summers commonly take advantage of various PD opportunities; both are very proactive with respect to increasing and improving their job skills.

7.2 Adequacy of Administrative Support:

The Department of Earth and Environmental Sciences has an annual budget to meet very basic needs. Over the last 8 years, this annual budget, excluding faculty and staff salaries, has remained approximately $23,000, which has been used mostly to cover general operating expenses (e.g. phones, copying, office supplies, instructional supplies), pay hourly wages, partly support conference travel (much of faculty travel has been covered by external grants), and partly support equipment/software purchases/maintenance. Over the same time frame, EES has increased its student majors and number of tenure-track faculty, who are actively engaging students in a variety of high-impact educational experiences (HIEEs). These are not inexpensive. The ever-increasing costs associated with field trips, lab equipment/consumables, and software licenses, among other expenses, will be unsustainable if we are unable to find more institutional support and/or raise course fees.

The Department collects **course fees** totaling about $3500 per year for introductory labs (GEO 1115) and for computer-intensive geospatial classes (GEO 3710, 3720, 3840, 4200). These funds are used to replace and improve lab supplies for the introductory labs, and to help cover computer/hardware expenses and software licensing in the geospatial classes. We reduce costs for GIS software licensing by being part of a cooperative program with other Utah institutions of higher education, and have received funds from other WSU constituencies that use the GIS software to help cover costs. However, covering on-going software licensing costs remains a challenge. Additionally, in junction with our move into the Tracy Hall Science Center in 2016, the Dean's Office provided substantial funding for new equipment. In addition, Lastly, the department is very appreciative of the administration's support for sabbatical leaves of absence.

Weber State University supports a vigorous and well-funded **Office of Undergraduate Research (OUR)**. Students apply on a competitive basis for research funding and/or conference-travel funding. EES students have been very successful in obtaining funding to support their undergraduate research. Additional support for UR comes from various faculty grants, the Dean's Office, and the department. Undergraduate research is a highlight of our department (see sections 6.7.3 and Appendix H). Faculty work with the **Office of Sponsored Projects (OSP)** to obtain and help administer grants and contracts, with an OSP liaison specifically assigned to the College of Science.

The College of Science, including EES faculty and staff, works closely with the central **Development Office**. Normally, there is a senior development director assigned to the college. At present, that position is vacant and the College is working with an interim director, who EES works with to obtain donations and cultivate ties with alumni and friends of the department. Owing to the generosity of alumni, emeritus faculty, friends of the department, and Dominion Energy, we are fortunate to be able to offer a number of named departmental-level scholarships each academic year. In addition, in 2016 the department received a very generous endowment from the Barker Family Trust. The earnings from this fund provide much-needed discretionary funds to assist the department with emergencies and strategic initiatives. Lastly, EES students routinely receive awards from the Utah Geological Association and the Golden Spike Gem and Mineral Club to support scholarships for the required summer field camp course for geology majors.

7.3 Adequacy of Facilities and Equipment:

The Department of Earth and Environmental Sciences is housed in the new Tracy Hall Science Center, which provides well-equipped analytical labs for research and teaching. Dave Matty and Adolph Yonkee have worked tirelessly over the past couple of years to select, purchase, install and calibrate a wide variety of new analytical instruments for the college and the department.

7.3.1 Equipment shared among College of Science departments:

• FEI Quanta 250 Environmental SEM

This scanning electron microscope is capable of imaging a variety of samples, at resolutions down to ~10 nm, under high-vacuum, low-vacuum (10-100 Pa), and environmental (up to 1000 Pa and water saturated with addition of a Peltier cooling stage) conditions. The instrument is equipped

with a backscatter electron detector, secondary electron detector (for high vacuum conditions), large field detector (for low vacuum conditions), and cathodoluminescence detector. The chamber can hold samples up to 50 mm in diameter. The instrument was recently upgraded with a state-of-the art energy dispersive spectrometer (Thermo UltraDry EDS) and software (Thermo Pathfinder Pinnacle), which provide qualitative, semi-qualitative, and quantitative (subject to characterization of appropriate standards) chemical microanalysis of solid materials, including abilities to do X-ray line scans, X-ray elemental maps, and phase maps.

• Rigaku MiniFlex X-ray Diffractometer
This benchtop, computer-controlled X-ray diffractometer is used for identification of unknown powdered crystalline compounds and determining atomic structures of crystalline materials.

• Rigaku Supermini 200 X-ray Fluorescence (XRF) Spectrometer
This benchtop, sequential wavelength-dispersive X-ray fluorescence (WDXRF) spectrometer is used for elemental analysis of oxygen (O) through uranium (U) in a variety of solid and liquid materials. The instrument can analyze complex matrix materials with a wide range of elemental concentrations, from trace (sub-ppm levels) to high concentration (wt%) levels. The instrument has a 200 W X-ray tube, and LiF(200), PET, and RX25 crystals, and software to support qualitative, semi-quantitative, and quantitative analysis protocols.

• Thermo iCAP 7400 Duo ICP-OES
This inductively coupled plasma optical emission spectrometer is capable of determining concentrations of most elements in liquid solutions to levels less than 1ppb. The instrument provides both axial and radial plasma view optics, which enhances analytical performance. The instrument is capable of analyzing solutions with high concentrations of dissolved solids (such as Great Salt Lake waters), as well as those with high organic contents. The instrument is equipped with an autosampler surrounded by an ULPA-filtered enclosure to speed analysis and limit potential contamination.

• Thermo iCAP RQ ICP-MS
This inductively coupled plasma mass spectrometer is capable of determining elemental concentrations to sub-parts per trillion levels, and isotopic ratio information if needed. The instrument includes spray chamber and torch capable to generate stable plasma, high precision sample and skimmer cones, a He-O collision/reaction cell used to both decrease interferences and enhance sensitivity for certain elements, and sensitive mass spectrometer. Integrated software provides for instrument tuning, sample analysis, and method development. The RQ is also equipped with an autosampler surrounded by an ULPA-filtered enclosure to speed analysis and limit potential contamination.

• Environmental Chemistry Lab (TY 215) with a range of sample preparation equipment including a CEM MARS 6 microwave digestion system, Katanax X-300 high-performance furnace, fume hood with acid storage, clean hood with HEPA filtration, analytical balances, and appropriate Teflon and glassware. The CEM MARS 6 system provides complete sample digestions of many materials for ICP analysis, including plant materials, animal tissues, foods, oils, natural waters, fertilizers, pharmaceuticals, ceramics, soils, most powdered rocks, and inorganics. The Katanax

furnace safely and automatically melts samples to make beads for XRF and has a magnetic stirring mechanism for pouring melts in acid solutions for used by ICP/AA. The X-300 is fully automated, comes pre-loaded with numerous fusion programs for specific applications, and can easily be programmed for specific needs.

• **Nano Pacific Atomic Force Microscope** for surface characterization to the nanometer scale. An attachable environmental cell allows observations in liquids.

• **Computational Lab/Classroom (TY 127)** with 20 PC work stations, link to large-format printers, and software including *ArcGIS* and multiple extensions, *ENVI* and *IDL* for image processing.

7.3.2 Equipment housed in the department:

• **Sample/Rock Preparation and Mineral Separation Labs (TY 110 and TY 103)** with trim and slab rock saws, grinders/polishers, jaw crusher, rotary disc mill, shatter box, research grade sieve set, Frantz magnetic separators, and Wilfley water table. We are in the process of obtaining supplies for heavy liquid separation of minerals

• **Introductory Geoscience Classroom (TY 211**) with an extensive teaching collection of common rocks and minerals, as well as topographic and geologic maps for introductory labs.

• **Advanced Geoscience Classroom (TY 217)** with 16 student petrographic microscopes (Leica DMP) and microscope with high resolution video camera and software to display images.

• **Geomicroscopy Lab (TY 104)** with a research-grade petrographic microscope (Olympus BX51) with 8-megapixel color video camera and image analysis software, research-grade binocular picking microscope (Olympus SX) with multiple light sources and 5-megapixel video camera, and access to a Olympus BX41 fluorescence microscopy system.

• **Geochemistry/Biogeoscience Lab (TY 241)** with mixed-acid and standard fume hoods, uv-vis spectrophotometer (Cary 60), cubit fluorometer for DNA quantification, and glassware.

• **Geoscience Collections Area ("Rock Room"/TY 216)** containing extensive rock, mineral, fossil, and thin section collections, including petro-tectonic suites.

• **Field and surveying equipment** including Brunton compasses, optical levels and stadia rods, 20 handheld computer GPS units (Trimble Juno with ArcPad for recording/ plotting data), Leica Geosystems total surveying station, drones, and ground penetrating radar.

• **Emriver EM2 stream table and Emriver flume (TY 103)** for demonstrating stream and sediment transport processes.

Significant equipment improvements have been made within the College of Science and our department over the last 5 years, including acquisition of new XRF, ICP-OES, ICP-MS, and sample preparation equipment, along with upgrades to the SEM, computational lab, and mineral

separation equipment. The new lab spaces in the Tracy Hall Science Center have also improved access and visibility of instrumentation. Facilities are adequate to provide students with training in many geospatial and environmental applications. Although we have made improvements and incorporated equipment into many classes and research projects, paying ongoing costs of maintenance contracts and supplies is a challenge that is only partly covered by existing budgets, research grants, and student fees. Importantly we were able to hire a laboratory manager who helps with the equipment, but a college wide technician to facilitate use of the wide range of equipment is still needed.

7.4 Adequacy of Library Resources:

EES faculty, staff, and students have access to excellent central-library resources. Students use a variety of library materials for writing exercises, literature searches, labs in a number of classes, and research projects. The Stewart Library has a dedicated science librarian who consults with EES faculty to update and add library resources, and who notifies them of new items of interest. The department, as well as individual EES faculty members, frequently recommend the purchase of new books and monographs, sample sets, and other materials. The library licenses many full-text databases, including ScienceDirect (203 Earth science journals and 263 environmental science journals), Wiley Online Library (over 500 Earth science journals and 100 environmental science journals, previously called *Wiley Interscience*), and *SpringerLink* (140 Earth science journals and 67 environmental science journals), all three of which have been available to students and faculty since before 2012. More recently licensed databases important to the Earth & environmental sciences include AGU 100 (21 geoscience journals, previously the American Geophysical Union Digital Library), the Environmental Studies and Policy Collection (84 environmental science and technology journals), and the National Geologic Map Database. In addition to these, the library maintains licenses to GeoRef, a geoscience search engine, and Scopus, an index and analytical tool for the sciences. Traditional (hard copy) journal subscriptions continue to decrease due to high costs and the emerging preference for online full-text access. The library currently supports approximately 10 print-based journal subscriptions in the Earth and environmental sciences, down from approximately 25 in 2012. Students and faculty also have access to an excellent interlibrary loan system (*Illiad*) and thousands of regional maps covering the Great Basin region and the surrounding states in the holdings of the Stewart Library.

8. RELATIONSHIPS WITH EXTERNAL COMMUNITIES

8.1 Description of Role in External Communities:

EES faculty and staff have extensive contacts with governmental agencies, including the Utah Geological Survey, U.S. Geological Survey, USDA Forest Service, Utah Board of Education, NUAMES Academy, NASA, and county/city GIS and planning groups. Faculty members have undertaken a number of collaborative projects with these agencies, and faculty serve on outside committees, such as the Utah State Mapping Advisory Committee. We also have contacts with geoscientists working for private environmental, geotechnical, and mining-service companies, who provide feedback on performance of graduates they hire. Many of these contacts have also resulted in student internships. Key contacts with external communities are listed in Appendix E.

The Department of Earth and Environmental Sciences supports GIS applications across the campus, including managing a site license for ArcGIS that is used by multiple academic programs, Stewart Library, and Facilities Management. Michael Hernandez heads the local GIS Users Group and provides training sessions on GIS to interested faculty.

The Department supports K-12 education in the community. We have been closely involved with the College of Science's Center for Science and Math Education (CSME), which was without a director at the time of our last program review (2012-2013). CSME is now under the direction of Jennifer Claesgens, who is re-evaluating the Center's mission, with EES representation on the CSME Advisory Committee. EES faculty have been actively involved with the Northern Utah Science Olympiad (extinct), the annual Ritchey Science & Engineering Fair hosted by the College of Science, MESA program, local Girl Scout troops, and giving presentations in local schools. Rick Ford served on a Utah Board of Education Writing Team to revise the teaching standards for Utah's 9th-grade Earth Science course, bringing them in alignment with the Next Generation Science Standards (NGSS).

EES faculty are actively involved in a number of professional organizations and in service to the geoscience community. We have chaired sessions and led field trips at professional meetings, served as judges for outstanding publication awards, and regularly serve as reviewers for a number of geoscience journals. EES faculty routinely volunteer their time to review grant proposals and to serve on thesis committees for graduate students at other colleges and universities.

8.2 Summary of External Advisory Council Activities:

We organized and established the Geoscience Advisory Council (GAC) in Fall 2013 (renamed the **Earth and Environmental Sciences Advisory Council**/EESAC in 2018). This group of approximately 15 departmental alumni and friends of the department has held regular biannual meetings (fall and spring) since that time. In addition to providing regular feedback about workforce trends and hiring, the EESAC has planned and executed two very successful alumni events aimed at reconnecting graduates to the department: Antelope Island Picnic and GeoHike (October 2015); THSC Open House & Tailgate Party (October 2017). The EESAC has also been instrumental in providing internships for our students and providing feedback regarding proposed changes to our curricula and department name. The EESAC is also planning an Earth Science Career Day (February 28, 2020) for Spring semester, which will bring recent departmental alumni back to campus to share information and advice with our students about their job searches and day-to-day work as entry-level geoscientists. In addition, we will continue to closely monitor employment trends and professional licensing requirements and to adjust course content and other department activities accordingly. The EESAC is the primary tool to be used to achieve this goal. We will also continue to utilize the robust workforce-related resources provided by the American Geosciences Institute (AGI). We are fortunate that the geoscience community is very much focused on community and graduate success at the national level.

8.3 "Next-Step" Success of Geoscience Graduates:

Arguably, one of best assessments of department-level work and responsiveness to the broader community is the "next-step" success of program graduates, in terms of their ability to enter the

workforce and/or their acceptance into graduate programs. Beginning in 2012, the Department of Earth and Environmental Sciences began compiling an alumni database to determine where (both in terms of geography and subspecialty) in the geoscience workforce our graduates landed. We now have data (Table 2) on the majority (approximately 89%) of our graduates going back to 2003. Over this time period, EES graduates have been very successful in finding employment within the geoscience workforce and/or being accepted into geoscience graduate programs. We are very proud of the 80+% placement. The data summarized in Table 2 also indicate that a WSU geoscience degree has provided entry into a wide variety of geoscience/STEM positions. The top

Table 2: Dept of Earth and Environmental Sciences:
Demographics & Graduate Data

Geoscience Majors: Enrolled Fall Semester 2019			
Degree Program	**Total**	**Males**	**Females**
Geology BS/BA	54	27	27
Applied Environmental Geosciences BS	31	13	18
Earth Science Teaching BS	3	2	1
TOTAL	**88**	**42**	**46**
Total Majors (incl. double majors&certificates)	109		

Geosciences Graduates (Summer 2003-Fall 2017): **Placement After Graduation (generally initial position)**		
Employment Sector	**#**	**Percent**
Mining geologist/mining support/exploration	25	20.7 %
Teaching/science education (K-12)	23	19.0 %
Environmental/hazards geologist or scientist	20	16.5 %
Petroleum geologist / oil & gas tech service	7	5.8 %
GIS Analyst/technician/surveyor	7	5.8 %
Other geoscientist/hydrologist	5	4.1 %
Other STEM-related position	5	4.1 %
Higher Education (geosciences)	3	2.5 %
Attending graduate school (geosciences)	7	5.8 %
Subtotal (Geoscience/STEM Positions)	**102**	**84.3 %**
Presently looking for geoscience position	2	1.7 %
Employed in a non-geoscience position	15	12.4 %
Not working outside the home	2	1.7 %
TOTAL	**121**	**100.1 %**
Attended graduate school	14	11.6 %
Whereabouts Unknown	15	

two employment sectors (other than secondary science education, where our Earth Science Teaching graduates have had nearly 100% placement) are mineral resources/mining and environmental geoscience. In addition, we were surprised to learn that only 12% of our recent graduates went on to graduate programs. This concern will be addressed during future program-level strategic planning, as we all would like to see this number increase for the long-term success of our graduates over their careers.

9. PROGRAM SUMMARY

9.1 Results from 2012-2013 Program Review:

The report (April 2013) of the external review team identified a number of challenges and made ten (10) recommendations for ways to improve the Department's programs. Since 2013, we have been able to implement each of the recommendations, to varying degrees, with the support of the Dean's Office and the central administration. Our actions are summarized below.

• **Recommendation 1:** The review team made a number of interconnected recommendations related to the department's geospatial science and technology curriculum and facilities.

Departmental Response: Michael Hernandez and Eric Ewert (Geography) secured a major NSF ATE grant (see section 6.3) to study and revise the geospatial curriculum. The new curricula for the geospatial analysis certificate of proficiency and geospatial studies minor took effect for Fall 2019. Michael was also involved in the programming and design of the computational classroom (TY 127) in Tracy Hall Science Center. This new classroom largely addressed the facilities issues raised by the review team.

• **Recommendation 2:** EES faculty need to routinely include salary and course-release funds (to pay for adjunct instructors) in the budgets for their external grant proposals.

Departmental Response: This is now the departmental norm and recent NSF grants have provided funds to pay adjuncts and thereby provide release time to faculty to devote to grant-related research.

• **Recommendation 3:** The department should be allowed to add a lab manager/instructor to its staff and should be allowed to replace retiring faculty, using this opportunity to increase faculty diversity while maintaining the department's success in serving a broad variety of students with variable goals and interests.

Departmental Response: Five years later, we were given the opportunity to make our case for a lab manager/instructor position, in the form of a departmental strategic plan, directly to the Provost's Office. The provost agreed to fund a geoscience lab manager and instructor position (fulltime, 10 months) and our first lab manager, Sara Summers (WSU '10), began work in January 2019. In addition, we were able to hire the top candidate during both the 2015 and 2016 faculty searches, resulting in increased gender diversity within the EES faculty (see section 6.5).

• **Recommendation 4:** The review team made a number of recommendations focused on upgrading the department's instructional facilities, especially the IT/AV systems in classrooms and storage of its extensive teaching collections (mineral, rocks, fossils).

Departmental Response: This recommendation was fully implemented with the department's move into Tracy Hall Science Center in 2016.

• **Recommendation 5:** The department should investigate offering an associate degree, as a milestone for students advancing through its 4-year programs.

Departmental Response: EES is presently working with the Departments of Chemistry & Biochemistry and Physics to study the feasibility of an Associate of Science in physical science, which could possibly be of benefit to students in all three departments.

• **Recommendation 6:** The review team recommended eliminating the second-semester course in remote sensing (GEO 4400) and a review of all the department's course offerings, with an eye to combining courses, eliminating obsolete courses, and adding new courses.

Departmental Response: The department engaged in 2-yr study of its curricula (2016-2018), resulting in a major curricular overhaul (see section 3.3) that took effect for Fall 2019, including the deletion of GEO 4400.

• **Recommendation 7:** The review team recommended that EES majors be required to completed their chemistry and physics requirements earlier in their program of study. Reviewing and establishing meaningful course prerequisites was also recommended.

Departmental Response: This issue has much discussed as part of our 2016-2018 curriculum revision and measures were taken to get students started on the 2-semester chemistry sequence sooner (we added CHEM 1200/1210 prereqs/co-reqs to the Earth Materials [GEO 2050] course). However, our students still struggle with proper course sequencing and we are concerned about the possible impact this issue may have on the recruitment and retention of ESS majors. Departmental discussions are ongoing.

• **Recommendation 8:** The review team recommended the use of student teaching assistants (TAs) in the lower-division labs to help with faculty workloads and to provide EES majors the opportunity to gain higher-education experience and skills.

Departmental Response: As the budget has permitted, we are now employing student TAs in a number of key courses.

• **Recommendation 9:** Increase the frequency of key courses, particularly Structural Geology (GEO 3060) and Petrology (GEO 4300).

Departmental Response: We have taken specific steps to eliminate course "bottlenecks." Beginning in academic year 2013-2014, we have offered GEO 3060 each fall semester; previously it was offered every other year. We also allowed geology majors to substitute Geochemistry (GEO

4550) for the required Petrology (GEO 4300) course. With the return of former dean Dave Matty to the faculty in 2019, we will be able to offer GEO 4300 each spring semester. In addition, we have also started offering Historical Geology (GEO 1220), Applied Hydrology (GEO 3080), and Intro to GIS (GEO 3710) during both the fall and spring semester; previously they were offered once a year.

• **Recommendation 10:** The review team strongly supported the hiring of a new director for the Center for Science and Math Education (CSME).

College of Science Response: The College of Science conducted a search for a new CSME director who would also have a faculty/teaching appointment in one of its departments. This search failed. Subsequently, a new director was hired as a fulltime staff position, reporting to the dean of the College.

9.2 Action Plan for Issues/Challenges Identified in Current Self Study:

9.2.1 Action Plan for Assessment-Related Findings: The departmental self-study documented in this report called to our attention the lack of progress we have made in the systematic assessment of student learning associated with high-impact educational experiences (see section 6.7), namely undergraduate research, internships, and study-abroad experiences. We will work with other College of Science (CoS) departments, and possibly the Office of Institutional Effectiveness, to identify appropriate assessment instruments that we can use going forward.

Although not addressed in this report, the recent study and revision of our various curricula (see section 3.3) once again highlighted the challenge our students face with respect to their mathematic preparation and ability to succeed in college-level mathematics courses. Beginning with spring semester 2020, we will help facilitate the formation of math study groups for EES majors.

A third issue that once again came to light for us during this process is the low percentage (< 15 %) of our graduates who go on to graduate school after completing their bachelor's degree (see Table 2). Recognizing the importance of an advanced degree in the long arc of a science career, we will investigate and consider ways in which we might be able to grow this number.

9.2.2 Action Plan for Staff, Administration, or Budgetary Findings: By far the most important staff-related challenge identified and documented in this self-study is the need for a college-level instrument/lab technician (see section 7.1). This position is crucial for the long-term sustainability and safety of the College's analytical laboratories. We will work with the other CoS departments and the dean to make the case for, and to identify funding for, such a position.

Although not addressed in this report, recent hiring of new faculty in the CoS and related tenure and promotion reviews have brought to light concerns related to faculty workloads, "burnout," and the support for grant writing and management. As a department, we are very pleased to see the dean of the college openly and vigorously working to understand these issues and to find solutions, in conjunction with the chairs and directors of the College.

Lastly, we must mention, as we do in every program-review self-study report, our very modest departmental budget (see section 7.2). We understand the constraints that are placed upon our dean, and the Provosts Office, in terms of adequately funding every department in the College of Science and across campus. However, if the administration is serious about supporting faculty in the use of the wide array of high-impact educational experiences that we value as part of a 21st-century bachelor's degree, then growing the funding for these practices is imperative.

END

APPENDICES

Appendix A: Student and Faculty Statistical Summary

(*Note*: Data provided by Institutional Effectiveness. This is an extract from the Program Review Dashboard and shows what will be sent to the Boards of Trustees and Regents)

	2014-15	2015-16	2016-17	2017-18	2018-19
Student Credit Hours Total	5,729	6,297	5,854	5,824	6,390
Student FTE Total	191.0	209.9	195.1	194.1	213.0
Student Majors	95	107	104	104	110
Program Graduates	18	19	17	12	13
Student Demographic Profile					
Female	32	40	48	50	52
Male	63	67	56	54	58
Faculty FTE Total	8.21	8.62	8.27	8.12	n/a
Adjunct FTE	2.13	2.35	2.42	2.09	n/a
Contract FTE	6.08	6.27	5.85	6.03	n/a
Student/Faculty Ratio	23.26	24.35	23.60	23.91	n/a

Appendix B: Faculty Profile

Faculty (current academic year)

	Tenured and tenure-track	Contract	Adjunct
Number of faculty with Doctoral degrees	9	0	1
Number of faculty with Master's degrees	0	0	4
Number of faculty with Bachelor's degrees	0	0	0
Other Faculty	0	0	0
Total	9	0	5

Tenure-Track/Adjunct Faculty Profile (CVs of Tenured/Tenure Track Faculty Available on Program Review Website)

Name	Rank	Tenure Status	Highest Degree	Years of Teaching	Areas of Expertise
Balgord, Liz	Assistant	Tenure-track	PhD	6	Sedimentology & tectonics
Barker, Helen	Adjunct	n/a	MS		General geology
Childs, Elise	Adjunct	n/a	MS		General geology
Ford, Rick	Professor	Tenured	PhD	27	Geomorphology & Quaternary geology
Frantz, Carie	Assistant	Tenure-track	PhD	4	Low-temperature geochemistry & geobiology
Ryan Frazier	Assistant	Tenure-track	PhD	2	Geospatial science & remote sensing
Gentry, Amanda	Adjunct	n/a	MS		General geology
Hernandez, Michael	Professor	Tenured	PhD	19	Geospatial analysis and geologic hazards
Matty, David	Professor	Tenured	PhD	25	Mineralogy, petrology, & geochemistry
Matyjasik, Marek	Professor	Tenured	PhD	23	Environmental hydrogeology
Nielsen, Greg	Adjunct	n/a	PhD		General geology
Sara Summers	Adjunct	n/a	MS		General geology
Tems, Caty	Assistant	Tenure-track	PhD	4	Paleoceanography & climate science
Yonkee, Adolph	Professor	Tenured	PhD	28	Structural geology

Appendix C: Staff Profile

Name	Job Title	Years of Employment	Areas of Expertise
Bischoff, Marianne	Administrative Specialist	8	Office management, budget reconciliation, eNewsletter
Sara Summers	Lab Manager & Instructor	1	Lab management, lab safety, field-trip logistics, lab instructor

Appendix D: Financial Analysis Summary
(Data provided by the Office of Institutional Effectiveness)

Program Name					
Funding	**14-15**	**15-16**	**16-17**	**17-18**	**18-19**
Appropriated Fund	$664,757	$642,374	$898,424	$729,873	$823,739
Other:					
Special Legislative Appropriation					
Grants or Contracts		$10, 654	$3,570		
Special Fees/Differential Tuition	$4,584	$9,491	$2,041	$4,773	$7,487
Total	$669,341	$662,519	$904,035	$734,646	$831,226
Total FTE	191.0	209.9	195.1	194.1	213.0
Cost per FTE	$3,305	$3,156	$4,633	$3784	$3,902

Appendix E: External Community Involvement Names and Organizations

Faculty	Projects and External Collaborations
Elizabeth Balgord	Impact of Climate Change on High Alpine Ecosystems • Mountain Environments Research Institute at Western Washington University • American Climber Science Program
	NSF Funded GEOPATHS to Increase Underrepresented Students in the Geosciences
	Method Development for Improved Zircon Separation • David Pearson, Idaho State University • Paul Link, Idaho State University
	Field Camp Curriculum Development and Teaching • Alexis Ault, Utah State University
Rick Ford	Sigma Gamma Epsilon (national student organization) • James Walters, University of Northern Iowa
	Post-Glacial Environmental Change in the Uinta Mountains, UT • Mitchell Power, Natural History Museum of Utah and University of Utah
	Quaternary Landscape Change in the Vicinity of the Coral Pink Sand Dunes, Colorado Plateau, UT • David Wilkins, Boise State University
	Developing New Science and Engineering Standards for 9th-Grade Earth Science • Richard Scott, Utah State Board of Education
	NUAMES North (charter school, offering concurrent enrollment) • Steve Davis, Principal
	Quaternary Geology of the Torrey 7.5-Minute Quadrangle, UT • Marjorie Chan, University of Utah • Bob Biek, Utah Geological Survey
Carie Frantz	Great Salt Lake Microbialites • Dennis Newell, Utah State University • Michael Vanden Berg, Utah Geological Survey
	Microbial Influence on Lacustrine Carbonate Geochemical Signals • Miquela Ingalls, California Institute of Technology • Katie Snell, University of Colorado Boulder • Elizabeth Trower, University of Colorado Boulder
	Geomicrobiology of rotten Arctic sea ice • Shelly Carpenter, University of Washington • Byron Crump, Oregon State University • Karen Junge, University of Washington • Bonnie Light, University of Washington • Mónica Orellan, University of Washington

	Green River Formation Stromatolites as Recorders of Paleoenvironmental Change • Stan Awramik, University of California, Santa Barbara • William Berelson, University of Southern California • Frank Corsetti, University of Southern California • Daniel Cupertino, University of California, Santa Barbara • Taleen Mahseredijan, University of Southern California • Victoria Petryshyn, University of Southern California
Ryan Frazier	• Txomin Hermosilla Gomez, Canadian Forest Services • Trevor Jones, University of British Columbia • Josef Navariltova, University of South Bohemia • Heather Fischer, Oregon State University
Michael Hernandez	Development of the Northern Utah Geospatial Technology Education Program (NUGeoTec) and Associated Geospatial Curriculum • Vincent A. DiNoto Jr., National Geospatial Center of Excellence, Jefferson Community and Technical College • Chris Carter, Old Dominion University
	Geospatial Modeling of the Effects of Historic Forest Disturbances on Water Quality and Flow in the Interior Western U.S. – Nutrient Loss Model Development within a GIS Platform • Sara Goeking, US Forest Service-Rocky Mountain Research Station • Gretchen Moisen, US Forest Service-Rocky Mountain Research Station • Nicholas Shaw, Weber State University Botany graduate
	Survey of Mars South Polar Craters for Subsurface Water Ice – Geospatial Data Mapping and Analysis • John Armstrong, Department of Physics, Weber State University
David Matty	N/A
Marek Matyjasik	Modeling of the Effects of Historic Forest Disturbances on Water Quality and Flow in the Interior Western U.S. – Nutrient Loss Model Development within a GIS Platform • Sara Goeking, US Forest Service-Rocky Mountain Research Station • Gretchen Moisen, US Forest Service-Rocky Mountain Research Station • Nicholas Shaw, Weber State University Botany graduate
	Dissolution of Lead and Arsenic Minerals at Atomic Scale • Tomasz Bajda, Academy of Mining and Metallurgy (Poland) • Maciej Manecki, Academy of Mining and Metallurgy (Poland)

Caitlin Tems	Tracking Fluctuations in the Eastern Tropical North Pacific Oxygen Minimum Zone • Will Berelson, University of Southern California • Alexander van Geen, Lamont-Doherty Earth Observatory at Columbia University • Steve Lund, University of Southern California
	Improving Science Communication and Developing Ocean Science Career Pathways through Educational Collaboration • Emily Rivest, Virginia Institute of Marine Science • Regis Komperda, San Diego State University
Adolph Yonkee	Geologic Mapping of Quadrangles in Northern Utah • Bob Biek, Utah Geological Survey • Zach Anderson, Utah Geological Survey • Adam McKean, Utah Geological Survey • Grant Willis, Utah Geological Survey
	Hydrolytic Weakening and Rheology • Dyanna Czeck, University of Wisconsin-Milwaukee
	Neoproterozoic tectonics and Snowball Earth • Carol Dehler, Utah State University
	Structural and Geochemical Studies of Fluid-Rock Interaction in Fold-Thrust Belts (NSF Grant, co-PI) • Gautam Mitra, University of Rochester,
	Thermochronometric Studies of Fold-Thrust Systems • Danny Stockli, University of Texas-Austin • Mike Wells, University of Nevada-Las Vegas
	Structural and Paleomagnetic Studies of Curved Mountain Systems (NSF Grant, co-PI) • Arlo Weil, Bryn Mawr College
	Service on Thesis Committees of External Students • Utah State University • University of Nevada-Las Vegas
Departmental Advisory Council	• Holly Barker, Retired Teacher, Weber School District • K. Scott Barker, Retired Teacher, Ogden School District • Steve Barker, Retired • Deidre Lombardi Beck, Environmental Scientist III, Utah Department of Environmental Quality • Jessica Castleton, Geologist, Utah Geological Survey • Alison Corey, GIS Specialist, Weber County • John Diamond, Senior Project Manager, Kleinfelder (Chair) • Tyson Grover, K-12 S.T.E.M. Section Director, Davis School District • Joe Havasi, Director of Natural Resources, Compass Minerals

	• Chris Howell, Environmental Response and Remediation, Utah Department of Environmental Quality • Jeff Kolmel, Davis County Health Department • Mike Lowe, Retired Geologist, Utah Geological Survey • Stephen McKay, Geologist, McKay Mineral Exploration, LLC • Miranda Menzies, Retired Geologists, URS Corp. (Vice Chair) • Matt Patterson, Science Curriculum Coordinator, Weber School District • Susan Thiros, Retired Hydrologists, USGS • Cameron Thompson, Senior Geologist, Crescent Point Energy Corp.

Appendix F: Site Visit Team (both internal and external members)

Name	Position	Affiliation
Susan Harley, Ph.D.	Professor	Weber State University
Michael Bunds, Ph.D.	Professor	Utah Valley University
Wing Cheung, Ph.D.	Professor	Palomar College
Lisa Collins, Ph.D.	Professor	Santa Monica College

Appendix G: Brief History of the Department of Earth and Environmental Sciences

1889 **Weber Stake Academy** was founded by the L.D.S. Church to provide religious and secular education in the Ogden area at preparatory and high school levels. Beginning with the second academic year (1889-1890) a course in geology was offered, probably taught by Louis F. Moench (1846-1916), the academy's first principal.

1896 John Gustave Lind (1867-1944) joined the faculty as a science instructor. As a teenager, Lind had worked as a tool boy in the mines at Park City. Later he earned a Normal Course certificate (1891) from the University of Deseret (precursor to the University of Utah) and a Bachelor of Science (1893) degree in general science from the University of Utah. For much of his career Lind was a one-man Department of Science, teaching courses in geology, mineralogy, chemistry, physics, zoology, physiology, physical geography, and Latin.

1908 The name of the school was changed to **Weber Academy**.

1910 In 1906 John Lind was called on an L.D.S. mission in Europe but was given a medical release due to health issues. He remained in Germany through 1910 pursuing graduate studies at the University of Jena (Germany) and Heidelberg University. Lind completed his doctorate in geology at Heidelberg in June 1910 and returned to Weber Academy for the 1910-1911 academic year, becoming the first Weber faculty member to hold a Ph.D. Professor Lind continued teaching at the college through the spring of 1938.

1916 The academy added college-level instruction as part of a two-year Advanced Normal Course for the preparation of public-school teachers. John Lind taught the first college-level geoscience courses in general geology and mineralogy during the 1916-1917 academic year.

1918 Weber Academy became **Weber Normal College** and the quarter system was adopted beginning with the 1918-1919 academic year.

1922 The school's name was changed to **Weber College** and the first Associate in Arts (A.A.) degrees were awarded during the May 1923 commencement ceremony. In addition, the high school curriculum was phased out at the end of the 1922-1923 academic year.

1933 Ownership and management of Weber College was transferred to the state of Utah effective July 1, 1933. Weber College would serve as the state junior college for northern Utah for the next 30 years. The **Department of Geology, Geography, and Mineralogy** was organized within the Division of Physical Sciences (the name of the department was shortened to **Geology & Geography** the next year). Walter Richard Buss (1905-2000) joined John Lind on the faculty and taught various geology, geography, and botany courses until his retirement in 1974. After Lind's retirement in 1938, Buss was a one-man department for much of his tenure at Weber College. Buss would go on to earn a Ph.D. from Stanford University in 1964.

1936 Walter Buss offered the first of many multi-day field trips by bus to Zion and Bryce Canyon National Parks. These annual field trips to explore the geology of the national parks would be very popular with Weber students for the next 35 years.

1952 The Department of Geology & Geography moved from the historic downtown Ogden campus into **Building 4** on the new Harrison Boulevard campus.

1962 The 1962-1963 academic year was the first year in which upper-division courses were offered by the college. The Department of Geology & Geography offered a minor in geology along with its first upper-division courses in geomorphology, structural geology, and paleontology. Geology & Geography had been a two-man department since 1960 when Dallas O. Peterson (Ph.D. Washington State University) joined the faculty.

1963 At the beginning of the 1963-1964 academic year the college, now named **Weber State College**, became a four-year baccalaureate institution, while retaining its open-enrollment junior-college mission. The Department of Geology & Geography had three (3) faculty members (2 geologists, 1 geographer) at this time.

1965 The baccalaureate degree (B.S./B.A.) program in geology was established and Roger D. Hoggan was the first student to complete the requirements; his Bachelor of Science in geology was conferred at the 1966 commencement. Hoggan would go on to earn master's and Ph.D. degrees from Brigham Young University, followed by an academic career at Ricks College, which later became Brigham Young University-Idaho.

1967 The Department of Geology & Geography became part of the School of Arts, Letters, & Sciences and moved into the new **Science Lab Building**, along with the other science departments. This was the first time since 1940 that all of the science departments were in the same building. By this time the department had grown to 5 tenure-track faculty members (3 geologists, 2 geographers). Richard W. Moyle (Ph.D. University of Iowa) became the third tenure-track geology faculty member when he started teaching in 1965.

1968 The Earth Science Teaching major (B.S.) was established. The Department of Geology & Geography had grown to include nine (9) faculty members, five (5) geologists (Buss, Peterson, Moyle, Neff, and Pashley) and four (4) geographers.

1970 The Earth Science Teaching minor was established.

1975 The first Bachelor of Science degrees in Earth Science Teaching were conferred. Beginning with the 1975-1976 academic year, the Department of Geology & Geography became part of the newly organized School of Natural Sciences.

1981 The new classroom building, **Lind Lecture Hall**, for the School of Natural Sciences was named and dedicated (April 23, 1981) in honor of Professor John G. Lind. Earlier that same month Professor Rodney Neff died in an automobile accident while conducting field-based research near Delta, Utah.

1983 The third floor of the Science Lab Building was named (Dr. Walter R. Buss Geology-Geography Complex) and dedicated (April 1, 1983) in honor of Professor Buss.

1985 Geology and Geography split into separate departments. The **Department of Geology** had five (5) faculty members: Moyle, Pashley, Ash, Wilson, and Cashman. (The Department of Geography remained in the School of Natural Sciences/College of Science until 1996, at which time it became part of the College of Social and Behavioral Sciences.)

1988 Dr. Walter R. Buss, Professor Emeritus, received an honorary *Doctor of Humanities* degree during Weber State's 1988 commencement ceremony.

1991 Weber State College became **Weber State University** on January 1, 1991, reflecting its growth and development into a comprehensive regional university offering a wide array of associate, bachelor's and master's degrees. The School of Natural Sciences became the College of Science.

1995 The Department of Geology became the **Department of Geosciences** when remote sensing, computer cartography (G.I.S.), and introductory meteorology were added to the department's course offerings and the Geospatial Analysis minor was transferred from the Department of Geography. The Department of Geosciences had grown to six (6) faculty members: Moyle, Ash, Wilson, Vaughn (transferred from the Department of Geography), Yonkee, and Eaton.

1996 The Applied Environmental Geosciences major (B.S.) was established. The first students to complete this program graduated in 1997.

1998 The University switched its academic calendar to the semester system. The Eta Gamma Chapter of *The Society of* ***Sigma Gamma Epsilon*** (National Honor Society for the Earth Sciences) was chartered within the Department of Geosciences.

2001 The Geomatics (Applied Mapping Sciences) Institutional Certificate program was established.

2008 Jeffrey G. Eaton (Ph.D. University of Colorado) was recognized and honored as a *John S. Hinckley Fellow*.

2009 W. Adolph Yonkee (Ph.D. University of Utah) was recognized and honored as a *Brady Presidential Distinguished Professor*.

2016 The Department of Geosciences, and the rest of the College of Science, moved into the new **Tracy Hall Science Center**, adjacent to the Clock Tower Plaza. Geosciences occupied research areas on level 1, teaching labs on level 2, and offices on level 3.

2018 The department updated its name to **Department of Earth and Environmental Sciences** as part of a major curriculum revision and increased emphasis on preparing students for careers in the environmental geoscience sector.

2019 W. Adolph Yonkee (Ph.D. University of Utah) was recognized and honored as a *John S. Hinckley Fellow*. With the support of the Provost's office, the department added a new lab manager position and new tenure-track positions in geospatial science and applied climate science. Former College of Science Dean Dave Matty returns to the faculty. The Department of EES had grown to nine (9) faculty members: Yonkee; Ford; Matyjasik; Hernandez; Matty; Balgord; Frantz; Tems; and Frazier.

2020 The Department of Earth and Environmental Sciences is the academic home to approximately 110 majors studying in four (4) baccalaureate degree programs (Geology BS, Geology BA, Applied Environmental Geoscience BS, and Earth Science Teaching BS) and currently has nine (9) tenure-track faculty members: Yonkee; Ford; Matyjasik; Hernandez; Matty; Balgord; Frantz; Tems; and Frazier.

Geology/Geosciences/Earth Science Faculty Who Earned Tenure, or Its Equivalent:

1. John G. Lind: 1896-1938; deceased (1867-1944)
   B.S. University of Utah 1893; M.A. Illinois Wesleyan University 1904;
   Ph.D. Heidelberg University (Germany) 1910

2. Walter R. Buss: 1933-1974; deceased (1905-2000)
   B.A., M.A. Brigham Young University 1930, 1933;
   Ph.D. Stanford University 1964

3. Dallas O. Peterson: 1960-1970; deceased (1925-2004)
   B.S., M.S. Brigham Young University 1952, 1953;
   Ph.D. Washington State University 1959

4. Richard W. Moyle: 1965-1996; deceased (1930-2017)
   B.S., M.S. Brigham Young University 1952, 1958;
   Ph.D. University of Iowa 1963

5. Thomas R. Neff: 1968-1981; deceased (xxxx-1981)
   B.S., M.S. University of Utah 1960, 1963;
   Ph.D. Stanford University 1969

6. E. Fred Pashley, Jr.: 1968-1995; deceased (1930-2017)
   B.S., M.S. The Ohio State University 1952, 1956;
   Ph.D. University of Arizona 1966

7. Sidney R. Ash: 1970-1997; deceased (1928-2019)
A.B. Midland Lutheran College 1951;
B.A., M.S. University of New Mexico 1957, 1961;
Ph.D. University of Reading (England) 1966

8. James R. Wilson: 1981-2014; *Professor Emeritus*
B.S. Auburn University 1967; M.S. University of Tennessee 1973;
Ph.D. University of Utah 1976

9. Patricia H. Cashman: 1982-1988
B.S. Middlebury College 1972;
Ph.D. University of Southern California 1979

10. W. Adolph Yonkee: 1991-present
B.S., M.S. University of Wyoming 1980, 1983;
Ph.D. University of Utah 1990

11. Jeffrey G. Eaton: 1993-2015; *Professor Emeritus*
B.Mus. Manhattan School of Music 1971; M.S. University of Wyoming 1982;
Ph.D. University of Colorado 1987

12. Danny M. Vaughn: 1995-2002
B.S., Ph.D. Indiana State University 1978, 1984

13. Richard L. Ford: 1996-present
B.S. Virginia Polytechnic Institute & State University 1978;
M.S. University of New Mexico 1986;
Ph.D. University of California, Los Angeles 1997

14. Marek Matyjasik: 1997-present
M.S. Warsaw University (Poland) 1988;
Ph.D. Kent State University 1997

15. Michael W. Hernandez: 2003-present
B.S., M.S. Louisiana Tech University 1984, 1990;
Ph.D. University of Utah 2004

16. David J. Matty: 2011-present (2011-2018, Dean of the College of Science)
B.S. Central Michigan University 1977; M.A. Portland State University 1980;
Ph.D. Rice University 1984

Geology/Geosciences/Earth & Environmental Sciences Department Chairs:

1. John G. Lind: 1916-1933, Department of Physical Science;
1933-1938, Department of Geology & Geography.
2. Walter R. Buss: 1938-1967

3. Dallas O. Peterson: 1967-1970
4. Richard W. Moyle: 1970-1973 & 1985-1988
5. Deon C. Greer (Professor of Geography): 1973-1978
6. Sydney R. Ash: 1978-1985 & 1993-1997
7. E. Fred Pashley, Jr.: 1988-1993
8. W. Adolph Yonkee: 1997-2012
9. Richard L. Ford: 2012-present

Sources:

Buss, W.R., 1945, Memorial to John Gustave Lind: Proceedings of the Utah Academy of Sciences, Arts, and Letters, v. 22, p. 16.

Buss, W.R., 1988, Science at Weber College, 1933-1974, a great school, a great group of teachers, *in* Sadler, R.W., editor, Weber State College: A Centennial History: Salt Lake City, Publishers Press, p. 198-211.

Hall, C.H., 1969, The Development of the Curricula at Weber State College 1889-1933: Ogden, Utah, Weber State College, 158 p.

Thompson, P.H., 1993, A Commitment to Learning, Weber State University, 1889-1993: New York, The Newcomen Society of the United States, 24 p.

Weber State University catalogs, 1897-2012.

Acknowledgments:

We thank Andrew Rabkin, University Archives Coordinator, for his assistance in finding materials used to compile this departmental history.

End

Appendix H: Undergraduate Research Projects Sponsored by EES Faculty (2015-2019)

A. Elizabeth Balgord: Undergraduate Research Projects at Weber State Since 2015

1. ***The Control of Bedrock Geochemistry on Water Quality in the Cordillera Blanca, Peru:*** 2016-present

Students: Analeah Vaughn, Carmen Longo, and Daksha Patel

This work is being done with an interdisciplinary, international group studying the impact of climate change on high alpine environments. I have traveled to Huaraz, Peru with three students over the past three years to conduct fieldwork. Samples were then brought back for analysis at Weber State University and the University of Wisconsin-Eau Claire. Students have presented this work at multiple meetings.

Funded Undergraduate Research Proposals

Analeah Vaughn: Timing and Magnitude of Uplift in the Cordillera Blanca, Peru, *$3492.50*, 2018
Carmen Longo: Geochemistry and Mapping in the Cordillera Blanca, Peru, *$3492.50*, 2018
Daksha Patel: Water Quality in the Cordillera Blanca, Huascaran, Peru: *$2590*, 2017

Abstracts (* student author)

*Vaughn, A., Balgord, E., Diedesch, T. F., All, J., Sofield, R., 2019, Tracking Glacial Retreat in the Peruvian Andes: Geologic Mapping in the Cordillera Blanca Documents Newly Exposed Sources of Water Contamination: Geological Society of America Abstracts with Programs, v. 51, n. 40

*Vaughn, A., *Longo, C., **Balgord, E. A.,** Diedesch, T. F., All, J., 2019, The Impact of Bedrock Composition on Water Chemistry During Rapid Glacial Retreat in the Cordillera Blanca, Peru, 10th Annual Intermountain Sustainability Summit, Weber State University

Vaughn, A., Longo, C., **Balgord, E. A.,** Diedesch, T. F., All, J., 2019, D4eglaciation in the Cordillera Blanca and its Effects on Water Quality: 13th Annual Utah Conference on Undergraduate Research, Weber State University

*Morgan, C., Diedesch, T. F., **Balgord, E. A.,** 2019, Deformation and Metamorphism in the Roof of the Cordillera Blanca Batholith, Peru: Geological Society of America Abstracts with Programs, v. 50, n. 41

*Longo, C., **Balgord, E. A**., Diedesch, T. F., All., J., 2018, The Impact of Climate Change of Water Quality in the Cordillera Blanca, Peru: Geological Society of America Abstracts with Programs, v. 50, n. 6

*Patel, Daksha, **Balgord, Elizabeth**, and All, John, 2017, Bedrock Geochemistry and its Control on Water Quality During Rapid Glacial Retreat in the Cordillera Blanca, Peru: Geological Society of America Abstracts with Programs, v. 49, n. 6

2. ***Geologic History of the Silver Island Mountains of western Utah:*** 2019-present

Students: Patty Adams, Chantelle Anderson, Kylie Arcias, Michael Benini, Alexander Berniche, Saige Carter, Laura Dinnell, Michael Fifer, James Henderson, Stepfan Huntsman, Austin Jensen, Adam Lieberman, Jackson Smith, Brooklyn Smout, Morgan Stewart, Magan Tea, Natalie Waters, Courtney Whitworth, Elizabeth Williams

This work started as a course-based undergraduate research project and will be continued by a number of students in the coming semesters. Students mapped a new area in western Utah, along the Nevada border, in groups of five. In their groups they determined more specific research questions they were interested in and wrote proposals to fund their research projects. Students will be determining the age and chemical composition of multiple units in western Utah which will increase our understanding of the tectonic evolution of this area. Students also learned how to crush and process samples for geochemical and geochronologic analysis. Multiple students will be traveling it Idaho State University to continue mineral separations and to the University of Arizona to run samples on an LA-ICP-MS.

Funded Undergraduate Research Proposals
Chantelle Anderson: Geochemistry of Intrusive Rock in the Silver Island Mountains, $584, 2019
Brooklyn Smout: Evaluation of Economic Minerals in Utah's Silver Island Mountains, $710, 2019
Elizabeth Williams: Geochemistry of Volcanic Rocks from the Silver Island Mountains, $400, 2019
Kylie Arcias: Determining the Ages of Igneous Rocks in the Silver Island Mountains of Western Utah, $1,160, 2019

Abstracts (* student author)
*Anderson, C., *Smout, B., *Arcaris, K., *Williams, E., and *Smith, J., Balgord, E., 2020, Timing and Genesis of Magmatism in the Silver Island Mountains of Western Utah: National Conference on Undergraduate Research, Bozeman, MT
*Smout, B., *Anderson, C., *Smith, J., *Williams, E., *Arcaris, K., Balgord, E., 2020, Composition, Age, and Origin of Economic Mineralization in the Silber Island Mountains of Western Utah: National Conference on Undergraduate Research, Bozeman, MT

3. ***Geologic History of the Basement Rocks of Northern Utah, Farmington Canyon Complex and Grouse Creek Block***

Students: Austin Jensen, Marshall Wayment, Keilee Stratton, Alexander Berniche, Brooklyn Smout, Analeah Vaughn, Alexandra Giacomo, and Skadi Kobe (Utah State University)

This work is a collaboration with Dr. Yonkee from Weber State University and Dr. Potter from Utah State University. Students mapped and collected samples from the Farmington Canyon Complex and Grouse Creek block. A group of students traveled with Dr. Potter and I up to Idaho State University to learn how to crush rocks and separate them for zircons. Students are currently working on proposals to support a trip to the University of Arizona in the spring of 2020 to determine the age of the samples. Dr Yonkee and I are working to get all crushing and separation equipment operational at Weber State to allow students to complete the majority of their work on campus.

Funded Undergraduate Research Proposals
Skadi Kobe, Timing of formation and evolution of the Grouse Creek block of northern Utah, $2,500, 2019 (Utah State University)

4. ***Sedimentary and Paleontological Analysis of Late Mesozoic to Early Cenozoic Strata on the Colorado Plateau of Southern Utah****:* 2016-present

Students: Stepfan Huntsman, Tiffany Snider, Angela Jex, Destry DiViesti, Kelsey Robonson, Raquel Robello, and Peter Melrose
Students have traveled to Southern Utah to work on sedimentologic and paleontologic field studies with Dr. Jeff Eaton and myself. Upon returning to Weber State students worked with me using petrographic microscopes to analyze samples. Two students presented their findings in 2017.

Funded Undergraduate Research Proposals
Raquel Robello: Sedimentology, Stratigraphy, and Petrographic Analysis of the Claron Formation, Southern Utah, *$720*, 2017

Abstracts (* student author)
*Robinson, Kelsey, *Robello, Raquel, K., **Balgord, Elizabeth**, Eaton, Jeffery G., 2017, Depositional Environment and Provenance of the Pink Member of the Claron Formation, Southwestern Utah: Geological Society of America Abstracts with Programs, v. 49, n. 5
*Robello, Raquel K., *Robinson, Kelsey, **Balgord, Elizabeth**, Eaton, Jeffery G., 2017, Sedimentology, Stratigraphy, and Petrographic Analysis of the Claron Formation: Implication for Eocene Paleoenvironments along the Southern Margin of the Aquarius Plateau, Utah: Geological Society of America Abstracts with Programs, v. 49, n. 5

5. ***Geoscience Education:*** 2017- present

Students: Analeah Vaughn, Nicole Kingsley, James Henderson, Alexandra Giacomo, Tiffany Snider

I have been working with students to teach them how to be undergraduate mentors for Concurrent Enrollment classes. I have been helping them develop, implement, and assess classroom activities for introductory courses. This work is being done as a part of a NSF-funded project designed to increase recruitment and retention in the department.

Abstracts (* student author)

*Henderson, J., *Kingsley, N., Gentry, A., and Balgord, E., 2020, Adding Assessment and Active Learning Activities to a Lecture-based Concurrent Enrollment Introductory Geology Course to Promote Recruitment in the Earth Sciences: National Conference on Undergraduate Research, Bozeman, MT

B. Carie Frantz: Undergraduate Research Projects with Weber State students (Since 2016)

1. ***Great Salt Lake microbialite formation and biogeochemistry:*** 2016–present

Investigations centering on the microbiology, chemistry, and biogenicity of Great Salt Lake's microbialites. Projects involve fieldwork, lab analysis, and geochemical modeling.
Students: Kristina George (Microbiology), Connor Harding (Microbiology), Mason Burningham (Microbiology), Joshua Gee (Microbiology), Steven Moore (Geology), Dezmond Swain (Microbiology), Jess Gann (Microbiology), Kristen Mayfield (Microbiology), Kuyler Thompson (Geology), Cooper Park (Microbiology), Kolby Robinson (Geology)

Funded Undergraduate Research Proposals

2019 Kristina George & Connor Harding: Enhanced cultivation of Great Salt Lake oxygenic phototrophs, $612

2018 Mason Burningham, Joshua Gee, Steven Moore: Ion source for microbialite communities, $690

2017 Jess Gann, Kristen Mayfield: Exploring chemical environments surrounding microbialites in the Great Salt Lake, $731

Abstracts (* student author)

C. Frantz, M. Matyjasik, K. Thompson*, Weber State University Geomicrobiology & Geochemistry Students* (2018) Microbialites and Microbial Mineralization in the Great Salt Lake, Utah. American Association of Petroleum Geologists Annual Convention and Exposition, Salt Lake City, UT, USA: Poster.

C. Frantz, M. Matyjasik, D. Newell, M. Vanden Berg, C. Park* (2017) Questioning the Origin of the Great Salt Lake "Microbialites". American Geophysical Union Meeting, New Orleans, LA, USA: Talk.

C. Park*, C. Frantz (2017) Biogenic carbonate precipitation by Great Salt Lake microbialite inhabitants.
Rocky Mountain Geobiology Symposium, Golden, CO, USA: Poster, OUR Travel Grant.
Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

Department Seminars (* student author)

M. Burningham*, J. Gee*, S. Moore* (2018) Influence of groundwater on Great Salt Lake microbialite communities. Department of Earth & Environmental Sciences and Department of Microbiology joint seminar, Weber State University, Ogden, UT, USA

J. Gann*, K. Mayfield* (2017) Is microbial activity needed to precipitate carbonate minerals and build the Great Salt Lake "Microbialites"? Geomicrobiology Mini Research Symposium, Weber State University, Ogden, UT, USA

2. ***Microbial carbonate precipitation****:* 2016–present

Experimental and modeling work to assess mechanisms for microbial carbonate precipitation, especially in hypersaline conditions (e.g., Great Salt Lake).

Students: Jawaher Albulushi (Chemistry), Natalie Waters (Geology), Danielle Saxer (Geology), Courtney Burns (Microbiology), Maya Dial (Microbiology), Kristina George (Microbiology), Connor Harding (Microbiology), Derek Jennings (Microbiology), Thomas Lopez (Microbiology), Darian Santana (Microbiology), Josie Wood (Microbiology), Ryan Clay (Microbiology), Christian Curneal (Microbiology), Emily States (Microbiology), Kuyler Thompson (Geology), Serena Young (Microbiology)

Funded Undergraduate Research Proposals

2018 Courtney Burns, Maya Dial, Kristina George, Bruce Harding, Derek Jennings, Thomas Lopez, Darian Santana, Josie Wood: Precipitation of carbonate by viral lysis of cyanobacteria in GSL, $202

2018 Ryan Clay: Urease-facilitated carbonate precipitation by Great Salt Lake microbialite isolates, $777

2017 Kuyler Thompson, Serena Young: Feasibility of biocementing in Great Salt Lake and Uinta Basin, $2,328

2017 Ryan Clay, Christian Curneal, Emily States: Determining if GSL microbialite inhabitants can facilitate calcite precipitation, $286

Manuscripts with student (*) co-authors

R. Clay*, C. Curneal*, E. States* (2018) Determining if Great Salt Lake microbialite inhabitants can facilitate calcite precipitation. *ERGO* (Weber State University undergraduate research journal).

Abstracts (* student author)

D. Saxer*, C. Frantz (2019) Great Salt Lake carbonate modeling and precipitation. Rocky Mountain Geobiology Symposium, Boulder, CO, USA: Poster, CU Boulder Travel Grant.

K. George*, C. Harding*, C. Burns*, M. Dial*, D. Jennings*, T. Lopez*, D. Santana*, J. Wood*, C. Frantz (2019) Precipitation of Carbonate Minerals in the Great Salt Lake by Phage-Mediated Lysis of Autotrophic Bacteria. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

D. Saxer*, C. Frantz (2019) Precipitation of carbonate by Great Salt Lake Microbialite Communities: Geochemical modeling. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

D. Saxer*, C. Frantz (2019) Precipitation of carbonate by Great Salt Lake microbialite communities: Geochemical modeling and laboratory experiments. Utah Conference on Undergraduate Research, Ogden, UT, USA: Poster.

R. Clay*, D. Swain*, C. Frantz (2018) Determining if the Great Salt Lake microbialite inhabitants can facilitate carbonate precipitation. Rocky Mountain Geobiology Symposium, Golden, CO, USA: Poster, OUR Travel Grant.

D. Swain*, C. Frantz (2018) "Living Rock" Great Salt Lake microbialite exhibit for research, teaching, and outreach in the WSU College of Science. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

R. Clay*, C. Curneal*, E. States*, C. Frantz (2018) The role of urease in carbonate precipitation in the Great Salt Lake Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

K. Thompson*, S. Young*, C. Frantz (2018) Feasibility of biocementing in Great Salt Lake and Uintah Basin. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

Department Seminars (* student author)

N. Waters* (2019) Great Salt Lake carbonate precipitation: establishing an abiotic control. Department of Department of Earth & Environmental Sciences seminar, Weber State University, Ogden, UT, USA.

C. Burns*, M. Dial*, K. George*, C. Harding*, D. Jennings*, T. Lopez, D. Santana, J. Wood (2018) Precipitation of carbonates by viral lysis of cyanobacteria. Department of Earth & Environmental Sciences and Department of Microbiology joint seminar, Weber State University, Ogden, UT, USA

R. Clay*, C. Curneal*, E. States* (2017) The potential for enzymatic carbonate precipitation by urease activity in Great Salt Lake microbialite communities. Geomicrobiology Mini Research Symposium, Weber State University, Ogden, UT, USA

K. Thompson*, S. Young* (2017) Microbially-induced carbonate precipitation tests in Great Salt Lake sediments. Geomicrobiology Mini Research Symposium, Weber State University, Ogden, UT, USA

3. ***Rotten Arctic sea ice:*** 2014–present

Trained students in bioinformatics techniques to analyze DNA extracted from Arctic sea ice.

Students: Rachael Carter (Microbiology), Brynli Tattersall (Microbiology)

Abstracts (* student author)

R. Carter*, C. Frantz (2019) Microbial Diversity of Rotten Ice. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

C. Frantz, B. Light, B. Tattersall*, S. Farley*, S. Carpenter, M. Orellana, K. Junge (2017) Shifting Arctic sea ice microbial communities and habitat during summer ice "rot". Geobiology Society Conference, Banff, Canada: Poster.
B. Tattersall*, B. Crump, K. Junge, M. Orellana, S. Carpenter, B. Light, C. Frantz (2017) Characterizing algal community shifts in "rotten ice". Rocky Mountain Geobiology Symposium, Golden, CO, USA: Poster, OUR Travel Grant. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

4. ***Miscellaneous:*** ongoing…

Mentored research projects of students' own design.

Students:

James Hurford-Reynolds (Physics): X-ray fluorescence for mapping elemental chemistry in stromatolites
Laura Dinnell (Geology): Time-series mapping of Great Salt Lake brine chemistry
Brittany Betzer (Geology), Brooke Ford (Geology), Stepfan Huntsman (Geology), Jackson Smith (Geology), Brookyn Smout (Geology), Jessica Stokes (Chemistry), Keilee Stratton (Geology), Natalie Waters (Geology), Marshall Wayment (Geology): Radon hazards in Ogden residences
Hyrum Briscoe (Geology), Jessica Clark (Geology), Angela Jex (Geology), Aaron Phipps (Geology), Philip Sandgren (Geology), Danielle Saxer (Geology), Tyler Trussell (Geology): *Modeled effect of industrial waste in Promontory Point Landfill near the Great Salt Lake*
Megan McNabb (Geology): Biogenicity of carbonate deposits in swimming pool cement
Atherton Green (Chemistry), Daksha Patel (Geology), Orana Paulus (Geology), Gary Sticht (Geology): Modeling mercury in transported sediment under different scenarios of future Great Salt Lake levels
Dana Hoffman (Microbiology): Pigmented bacteria in Timpanogos Cave, Utah

Funded Undergraduate Research Proposals

2019 Brittany Betzer, Brooke Ford, Stepfan Huntsman, Jackson Smith, Brooklyn Smout, Jessica Stokes, Keilee Stratton, Natalie Waters, Marshall Wayment: Concentration of radon within soils and homes in the Ogden area, $168

Abstracts (* student author)

L. Dinnell*, C. Frantz (2019) An Interactive Time-Series GIS Map of the Great Salt Lake's Dynamic Chemistry. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.
J. Stokes*, B. Betzer*, B. Ford*, S. Huntsman*, J. Smith*, B. Smout*, J. Stokes*, K. Stratton*, N. Waters*, M. Wayment*, C. Frantz (2019) Concentration of Radon within Soil and Homes in the Ogden Area. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Talk.
H. Briscoe*, J. Clark*, A. Jex*, A. Phipps*, P. Sandgren*, D. Saxer*, T. Trussell*, C. Frantz (2018) Modeled effect of industrial waste in Promontory Point Landfill near the Great Salt Lake. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.
G. Sticht*, D. Patel*, O. Paulus*, A. Green*, C. Frantz (2017) Role of Great Salt Lake elevation on heavy metal concentrations. Weber State University Undergraduate Research Symposium, Ogden, UT, USA: Poster.

Department Seminars (* student author)

J. Hurford-Reynolds* (2018) Utah rocks: Elemental composition and climate evolution. Department of Physics seminar, Weber State University, Ogden, UT, USA
H. Briscoe*, J. Clark*, A. Jex*, A. Phipps*, P. Sandgren*, D. Saxer*, T. Trussell* (2018) Transport of toxic metals from proposed industrial waste in Promontory Point Landfill, Great Salt Lake. Department of Geosciences seminar, Weber State University, Ogden, UT, USA

A. Green*, D. Patel*, O. Paulus*, G. Sticht* (2017) Dust & Mercury: Modeling the future of the Great Salt Lake. Department of Geosciences Seminar, Weber State University, Ogden, UT, USA.

C. Michael W. Hernandez - Undergraduate Research Projects Since 2013

1. ***Effects of historic forest disturbance on water quality and flow in the Interior Western US:*** 2013 – present (Marek Matyjasik is PI; I am a co_PI)

Students: Chelsea Combe, T. Hathcock, Stephanie Mitts, Nicholas Shaw, Margaret Baker (University of Utah), Teri Cisney, Michael Fowles, Destry Divieste, Kolby Robinson, Judy Smith, Steven Moore, and Adam Lieberman.

A Joint Venture Agreement between U.S. Forest Service FIA and the Department of Geosciences at Weber State University (WSU) to address water resources studies as related to forest disturbances. Students' researched scientific literature, evaluated water quality data, and tested GIS-based watershed-level water quality model. Students worked on refining the data integration between WEPP, GeoWEPP, and the ArcMap model to estimate watershed-level release of phosphorous, nitrogen, and DOC for different periods after a forest fire.

Funded Undergraduate Research Proposals

$49,000 funded by USDA Forest Service. Students paid for undergraduate research from these funds.

Abstracts (* student author)

*Cisney, T., *Fowles, M.,* Shaw, N., and *Baker, M., 2018, Modeling of fluxes of Nitrogen, Phosphorus, and Carbon triggered by wild fires. Weber State University 14th Annual Undergraduate Research Symposium and Celebration; March 26, 2018; Poster Session 2, Poster 4. Abstract: p. 59.
Mentors: Dr. Marek Matyjasik & **Dr. Michael W. Hernandez**

Marek Matyjasik, **Michael Hernandez**, *Nicholas Shaw, *Margaret Baker, *Michael Fowles, *Teri Cisney, Angela Paige, Gretchen Moisen, 2017, Modelling of phosphorus fluxes produced by wild fires at watershed scales. American Geophysical Union, New Orleans, Louisiana, USA. Oral Presentation. Tuesday, December 12, 2017, 14:00 – 14:20. New Orleans Ernest N. Morial Convention Center, Rm 295-296.

Marek Matyjasik, **Michael Hernandez**, *Nicholas Shaw, *Margaret Baker, *Michael Fowles, Gretchen Moisen, 2017, Modelling of dissolved organic carbon fluxes triggered by forest wild fires in the Interior Western US. Goldschmidt International Geochemical Conference, Paris, France.

Matyjasik, M., Moisen, G., Frescino, T., Schroeder, T., **Hernandez, M.**, *Combe, C., *Hathcock, T., and *Mitts, S., 2014, Chemical Stream Water Indicators Of Forest Wild Fires In The Interior Western US: 2014 Geological Society of America Annual Meeting, October 19 – 22, 2014, Vancouver, British Columbia, Session No. 39 – Booth # 138. Geological Society of America Abstracts with Programs. Vol. 46, No. 6, p. 116.

Matyjasik, M., Moisen, G., *Combe, C., *Hathcock, T., *Mitts, S., **Hernandez, M**., Frescino, T., and Schroeder, T., 2014, Effects of historic forest disturbance on water quality and flow in the Interior Western US: XXIV International Union of Forest Research Organizations (IUFRO) World Congress, October 5 – 11, 2014, Salt Lake City, Utah. Poster presentation (Session D-05a: Managing forests and forest uses to protect and provide clean water), Program, p. 94.

2. ***Developing a Vision and Plan for the Northern Utah Geospatial Technology Education Program:*** 2017 – 2019 (student participation time frame)

Students: Teri Cisney, Ryan Isaacson, Kristi Torsak

This work was done as part of an NSF ATE grant to create the Northern Utah Geospatial Technology Education Program (NUGeoTec), and interdisciplinary program housed in both the Departments of Earth and Environmental Science and Geography. Students assisted with curriculum development, which includes mapping key skills defined in the U.S. DOL Geospatial Technology Competency Model (GTCM) to each new and revised geospatial course student learning objectives and assessment component. They evaluated current geospatial technology model course assignments published by the NSF-funded GeoTech Center for inclusion into our curriculum. They reviewed and determined course numbers and descriptions that would ensure consistency with state course articulation efforts. They also helped develop marketing, branding, and social media products for the program, including the web page.

Funded Undergraduate Research Proposals
$183,336 funded by NSF….students paid for their research from these funds.

3. ***Geospatial Analysis of Mars Imagery in the Tracy Hall Computational Research Laboratory***: 2016 - 2017 (John Armstrong – Physics, PI; I was co-PI)

Students: Casey Graham (physics), Andrew Nelson (physics), Carmen Longo (geosciences), Justin Samuels (botany), Corey Collatz (physics), Dennis Yu (geography), Orana Paullus (geosciences), Alex Lehr (physics), Adam Coss (physics), Nathan Henrie (geosciences)
A partnership between NASA's Nexus for Exoplanet System Science and Virtual Planetary Laboratory and Weber State University Physics Department and Geoscience geospatial program. Students used GIS to identify, describe, and select Mars southern craters from an image-based raster surface model and thermal imagery (THEMIS) that have characteristics indicating the presence of ice deposits.

Funded Undergraduate Research Proposals
$24,919 funded by NASA JPL…students paid for their undergraduate research from these funds.

Abstracts (* student author)
*Paulus, O., *Yu, D., *Lehr, A., *Graham, C., *Nelson, A., *Longo, C., *Samuels, J., *Collatz, C., *Coss, A., *Henrie, N., 2017, Survey of Mars South Polar Craters for Subsurface Water Ice, Utah Space Grant Consortium Annual Meeting, Weber State University, Ogden, UT, May 8, 2017. Poster.

4. ***A Global Forest Biomass Inventory Based Upon GLAS Lidar Data….Refining a sample design procedure for model-based estimation of global forest biomass inventory using GLAS lidar data:*** 2013 - 2014

Student: David Edwards

Worked with David to modify a sample design that developed a simple random sample of lidar shots which provided a valid sample for subsequent model-based estimation of biomass. He put in over 600 hours on this project. **Impact:** David developed many new skills in GIS and statistical processing. He presented his research at the WSU Sigma Xi student research session on April 8, 2014. He is also a co-author on a research poster I presented at the Association of American Geographers Annual Meeting in Tampa, FL (April 8 – 12, 2014). David is also a co-author on a peer-reviewed paper that was submitted to Remote Sensing of Environment as a short communication that was reviewed, initially rejected and is under revision.

Funded Undergraduate Research Proposals

$65,174.56 funded by NASA through partnership with US Forest Service Rocky Mountain Research Station….David was paid for his undergraduate research project from these funds.

Abstracts (* student author)

Hernandez, M.W., *Edwards, D., *Welch, J., Healey, S., Freeman, E., Lister, A.J., & Patterson, P.L., 2014), Refined Sample Design Procedure for Model-Based Estimation of Global Forest Biomass Inventory using GLAS Lidar Data. Association of American Geographers Annual Meeting, April 8 – 12, 2014, Tampa, Florida. Poster Session (Abstract published in proceedings).

D. Adolph Yonkee Undergraduate Research Projects at Weber State Since 2015

1. Fluid-flow systems during thrust faulting, Wyoming salient:2016-present, National Science Foundation funding

Students: Edward Zajack, Jason Whittier, Angela Jex, Hyrum Briscoe

This project is done in collaboration with faculty and graduate students from Rochester University and the University of Michigan. Students helped collect samples throughout Utah, Wyoming and Idaho. Lab work for this project includes cutting oriented samples using the rock saw, and looking at samples using the petrographic and scanning electron microscope.

2. Foreland deformation along the Argentina Andes: 2015-present, National Science Foundation funding

Students: Michael Garlick, Chase Dickinson, Kevin Rafferty, Ben Marconi

This project was done in collaboration with faculty and students from Bryn Mawyr College and researchers from the geologic survey in Mendoza, Argentina. I brought students for extended field work in the high Andes of Argentina. Some of the students also worked in the lab cutting oriented samples.

3. Farmington Canyon Complex: 2019-present

Students: Marshall Wayment, Austin Jensen, Marshall Wayment, Keilee Stratton, Alexander Berniche, Brooklyn Smout, Analeah Vaughn, Alexandra Giacomo, and Skadi Kobe (Utah State University)

This work is a collaboration with Dr. Balgord from Weber State University and Dr. Potter from Utah State University. Students mapped and collected samples from the Farmington Canyon Complex as a part of a 2-credit petrography course I taught during the spring of 2019. Following

that course multiple students wanted to continue working on the project. We have gone on two more trips to sample the Farmington Canyon complex and a join trip with students and faculty from Utah State University to collect samples of the Grouse Creek block in central Idaho. A group of students traveled with Dr. Potter and Dr. Balgord up to Idaho State University to learn how to crush rocks and separate them for zircons. Students are currently working on proposals to support a trip to the University of Arizona in the spring of 2020 to determine the age of the samples. Dr Balgord and I are working to get all crushing and separation equipment operational at Weber State to allow students to complete the majority of their work on campus.

End

Appendix I: DRAFT Curriculum for New Environmental Science (BS) Degree

Advisor: Dr. Rick Ford, 801-626-6942 rford@weber.edu

- **Program Prerequisite:** None
- **Minor:** Not required*
- **Grade Requirements:** A grade of "C-" or better in courses required for the major (a grade of "D+" is not acceptable). A 2.00 overall GPA is required by the university for graduation.
- **Credit Hour Requirements:** A total of 120 credit hours is required for graduation. Of this total, 58 credit hours in Environmental Science courses are required. Including the required support courses, 78-79 credit hours are required within the major. A total of 40 upper-division credit hours (courses numbered 3000 and above from any department) is required by the university for graduation.
- **Program Code:**
- **CIPC:**

** Though not required, students may benefit from completing a minor, especially one focused on developing workforce skills such as communication, data analytics, geospatial studies, or professional and technical writing. Students should consult with an advisor prior to adding a minor to their program of study.*

Advisement
All Environmental Science majors should meet with a faculty advisor at least annually for course and program advisement. New majors are strongly encouraged to meet with an advisor. Call 801-626-7139 for more information or to schedule an appointment.

Admission Requirements
Declare your program of study (see Enrollment Services and Information) with the program advisor. There are no special admission or application requirements.

General Education
Refer to Degree Requirements for Bachelor of Science requirements. The Quantitative Literacy (QL) requirement will be fulfilled by degree requirements (MATH 1050 QL or MATH 1080 QL or MATH 1210 QL). The natural science breadth requirement (LS/PS) will be fulfilled by degree requirements. The required support course ECON 1110 PS will count towards the social science (SS) breadth requirement.

Major Course Requirements for Environmental Science BS Degree

Environmental Science Core Courses (34 credit hours)
- BTNY 1403 LS – Environment Appreciation **Credits:** (4)
- GEO 1060 PS – Environmental Geosciences **Credits**: (3) **or**
  GEO 1110 PS – Dynamic Earth: Physical Geology **Credits:** (3)
- GEO 1115 – Physical Geology Lab **Credits:** (1)
- GEO 3010 – Oceanography and Earth Systems **Credits:** (3)

• GEO 3710 – Introduction to GIS **Credits:** (4)
• GEO 4990 – Geoscience & Society Seminar **Credits** (2)
• MICR 2054 LS – Principles of Microbiology **Credits:** (4)
• MICR 3502 – Environmental Health **Credits:** (2)
• PHYS 2090 PS – Energy and the Environment **Credits:** (3)
either
• BTNY 2104 - Plant Form and Function **Credits:** (4) **and**
• BTNY 3454 - Plant Ecology **Credits:** (4)
or
• ZOOL 1110 LS - Principles of Zoology **Credits:** (4) **and**
• ZOOL 3450 - Ecology **Credits:** (4)

Environmental Science Electives (24 credit hours minimum)
Select 24 additional Environmental Science elective credits, in consultation with your advisor, with at least 2 credits from each category. Some upper-division electives may have prerequisites not listed as an environmental science core or elective course. Those courses are marked with an asterisk (*) and students should consult with an academic advisor before adding them to their program of study.

Elective Category 1 – Ecology, Sustainability, & Natural Resources
• BTNY 2413 – Introduction to Natural Resources Management **Credits:** (3) **or**
GEOG 1500 PS – The Science of Global Warming **Credits** (3) **or**
GEOG 3060 – World Environmental Issues **Credits** (3)
• BTNY 3473 – Plant Geography **Credits** (3) (*)
• BTNY 3624 – Taxonomy of Vascular Plants **Credits** (4) (*)
• BTNY 3643 – Intermountain Flora **Credits** (3)
• BTNY 4950 – Advanced Field Botany **Credits** (1-5)
• MICR 3154 – Microbial Ecology **Credits** (4)
• ZOOL 3470 – Zoogeography **Credits** (3) (*)
• ZOOL 3500 – Conservation Biology **Credits** (3) (*)
• ZOOL 4480 – Aquatic Ecology **Credits** (4) (*)
• ZOOL 4490 – Marine Ecology **Credits** (4) (*)
• ZOOL 4640 – Entomology **Credits** (4) (*)

Elective Category 2 – Environmental Health & Planning
• MICR 3012 – Microbiology and Global Public Health **Credits:** (2)
• MICR 3403 – Tropical Diseases **Credits** (3)
• MICR 3484 – Environmental Microbiology **Credits** (4)
• MICR 4054 – Microbial Physiology **Credits** (4) (*)
• ZOOL 4900 – Topics in Zoology: Animal Toxicology **Credits** (3) (*)
• GEOG 3210 Urban Geography **Credits** (3) **or**
GEOG 4410 – Sustainable Land Use Planning **Credits** (3) **or**
SOC 3300 – Environment and Society **Credits** (3)
• GEOG 4420 – Advanced Urban and Regional Planning **Credits** (3)

Elective Category 3 – Earth Systems & Water Science

- BTNY/GEO 3214 – Soils **Credits** (4)
- GEO 3080 – Applied Hydrology **Credits** (4) (*)
- GEO 3150 – Geomorphology **Credits** (4) (*)
- GEO 3210 – Quaternary Environmental Change **Credits** (3) (*)
- GEO/MICR 3753 – Geomicrobiology **Credits** (3)
- GEO 4080 – Groundwater and Environmental Assessment **Credits** (4)
- GEO/CHEM 4560 – Environmental Geochemistry **Credits** (4) (*)
- GEOG 3050 – Weather and Climate **Credits** (3) **or** GEOG 3080 – Arid Lands **Credits** (3) **or** GEOG 3090 Arctic and Alpine Environments **Credits** (3)

Elective Category 4 – Laboratory, Data Analysis, & Workforce Skills

- CHEM 2310/15 – Organic Chemistry I **Credits** (5)
- CHEM 3000 – Quantitative Analysis **Credits** (4)
- CHEM 3050 – Instrumental Analysis **Credits** (4)
- CHEM 3070/75 – Biochemistry I **Credits** (5)
- CHEM 3610 – Foundations in Inorganic Chemistry **Credits** (4)
- GEO 3720 – Geospatial Analysis **Credits** (4)
- GEO 3840 – Remote Sensing: Principles & Methods **Credits** (4)
- GEO 4200 – Geospatial Data Acquisition **Credits** (4)
- GEO 4840 – Geospatial Internship **Credits** (1-3)
- GEOG 4400 – Cartography and Map Design **Credits** (3)
- MATH 3450 – Advanced Statistical Methods **Credits** (4)
- MATH 4400 – Statistical Analysis of Big and Small Data **Credits** (3)
- MATH 4910 – Senior Research Project **Credits** (3)
- BTNY/CHEM/GEO/MICR/PHYS 2600 – Laboratory Safety **Credit** (1)
- BTNY/CHEM/GEO/MICR/PHYS/ZOOL 4800 – *Undergraduate Research* **Credits** (1-3)
- BTNY/CHEM/GEO/MICR/PHYS/ZOOL 4890 – Cooperative Work Experience **Cr hr** (1-6)

Required Support Courses (20-21 credit hours)

- MATH 1050 QL – College Algebra **Credits:** (4) **or**
  MATH 1080 QL – Pre-calculus **Credits**: (5) **or**
  MATH 1210 QL – Calculus I **Credits:** (4)
- MATH 1040 QL – Introduction to Statistics **Credits:** (3) **or**
  MATH 3410 – Probability and Statistics I **Credits** (3) **or**
  SOC 3600 – Social Statistics **Credits:** (3) **or**
  PSY 3600 Statistics in Psychology **Credits:** (3)
- CHEM 1210 PS – Principles of Chemistry I **Credits:** (5) **and**
- CHEM 1220 – Principles of Chemistry II **Credits:** (5)
- ECON 1100 SS – Environmental Issues and Economic Policy **Credits:** (3)

Degree Summary (not part of catalog text)

Gen Ed Prereqs:	0-9 credits hours	CHEM 1200, ENGL 1010, MATH 1010
Gen Ed	19	EN (3), CIL (1), AI (3), SS (3), CA/HU (9)
Required Support	20-21	
ENVS CORE	34	[58 credit hours in the "major field"/ENVS, limit is 63]
ENVS ELECTIVES	24	
Free Electives	13-23	Could be used to complete a minor and/or to satisfy prereqs
TOTAL	**120**	

End RLF 18 December 2019

Appendix J: Bibliography of Educational Research and Commentary Used During Curriculum Revision (2018-2019)

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Developed from the Geoscience Employers Workshop, Summit on the Future of Undergraduate Geoscience Education and On-Line Survey
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