1. Department/Program Recommendations

1) Increase the number of undergraduate majors.
   a) Reinvigorating the B.A. Earth Science Degree (see item #2 below), which is more relevant to changing professional and societal needs than the current curriculum, may attract more majors.
   b) Have annual meetings with Earth Science community college instructors and make presentations at local community colleges in collaboration with the instructors.
   c) Hold a designated Geology Club meeting each semester for prospective Geology majors devoted to describing careers in geology and for students to informally meet some of our current majors.
   d) Place movies on the Department website of the capstone summer field trip to show students a personal connection to Geology.
   e) Act on the results of the fall 2017 survey of undergraduate students, which shows that students majored in geology largely because of their enjoyment of being outdoors and learning about nature.
   f) Reach out directly to students who have been accepted as Geology majors with the goal of achieving a higher rate of matriculated students.

We have begun taking some of these steps and have appointed a recruitment committee. These actions will require considerable time, and to sustain these efforts it is important to give assigned time (2 WTU) to a recruitment coordinator from this committee.
2) Update the B.A. Earth Science degree to give it an Earth Systems Science focus. An upper division Earth Systems Science class will be submitted to the College of Science Curriculum Committee in fall 2018 with the intent of offering the course in 2019-2020 and the degree modifications will be submitted to the same committee in fall 2019 for implementation in fall 2020. The modified degree will not require significant additional resources, as it will largely utilize a different set of pre-existing courses.

3) “Visioning sessions”. We will have two hour-long faculty meetings in fall 2018 dedicated to continuing our discussions of the aspirations of the faculty on the balance between teaching and research.

4) Increase digital mapping and use of technology in the capstone (Geol 129B, 129C) field course, and incorporate GIS in more classes in the curriculum. We anticipate ramping up our efforts in 2018-19. Resources needed will include hand-held GPS devices and continued support of ArcGIS software, which the Department can cover in a typical annual budget.

5) Add required day-long field trips for Geol 001 and Geol 009. Request for approval of the associated field trip fees for students of approximately $25-$30 on the basis of the fee for the broadly analogous Geol 007 trip, will be submitted in summer or fall 2018. These trips may also help with recruitment of majors.

6) Mentoring for non-tenured faculty members. Each of the three untenured faculty members will be assigned mentors in fall 2018. No additional resources are needed.

7) The Geology Minor will be advertised in G.E. classes beginning in spring 2018. No additional resources are needed.

8) An undergraduate or graduate student will be hired in fall 2018 as a tutor to help students having difficulties in geology major classes. The cost can be covered within the Department budget.

2. Progress on Previous Action Plan

1) An issue raised in the 2012 Program Plan was our desire to increase the number of undergraduate majors in Geology. A multi-faceted plan was developed to increase the awareness of careers in Geology. One focus was on GE students taking our introductory classes. We distributed a Powerpoint presentation for instructors to present in these courses. GE students interested in the major were invited to a special meeting of our Geology Club where they met Geology majors and faculty in an informal setting with lunch provided and learned more about careers in geology. In addition, a video was developed which was shown on laptops at College and University functions. A second initiative was designed to increase interaction with community college instructors in the Earth Sciences in the local service area (broadly defined). Many of our majors come as transfers from these colleges and the lead instructors at Cabrillo, De Anza, Gavilan, and Ohlone Colleges are graduates of our M.S. program. All of the instructors in the service area were invited to a Friday luncheon in Duncan Hall during which we updated them on the Department and discussions were held between all participants. In spring 2017, a workshop for De Anza College students considering Earth Science as a major was held in the Department.

It is difficult to assess the effectiveness of these endeavors. In terms of numbers of majors, there was an uptick in 2013-14, but the numbers have decreased in the last few years. The amount of time expended on recruitment has fluctuated and decreased with
time. This decrease in part reflects the loss of 30% of the tenured faculty who went on the FERP or left for other positions, thus increasing the governance workload for the remaining faculty members. The departure of Professor Hendricks was particularly costly, as he led our efforts in recruitment, but took a one-year sabbatical and then a year-long leave of absence before resigning from the university. Recent and planned future hires will strengthen our renewed recruitment efforts.

2) The Department was urged to seek SSETF funds for equipment. We submitted a proposal for $186,000, primarily for course support in Geol 137 (Introduction to GIS/GPS), Geol 237 (Advanced GIS/GPS Mapping), and new undergraduate (Geol 143) and graduate (taught as Geol 255) courses in active tectonics (active faulting) to be taught by Professor Blisniuk, a new assistant professor at the time. Other courses that would have been enhanced by the SSETF support were Geol 134 (Geomorphology) and Geol 234 (Advanced Geomorphology), both of which use GIS and GPS in labs. The Department’s proposal was viewed favorably by the Dean and was one of three put forward by the College. Unfortunately, during the review period the SSETF program was dramatically scaled back and none of the College of Science proposals were funded.

3) External Resource Development
Faculty members have been successful in obtaining individual external research grants. Since the last program plan, 26 grants totaling approximately $3,968,000 were awarded. Professor Blisniuk and Professor Gabet also applied (not funded) for equipment grants and Blisniuk did receive an e-campus grant to purchase two drones and gaming computer to set up a structure-from-motion system for her undergraduate and graduate active tectonics classes. She also wrote a proposal (not funded) to the National Science Foundation for a major Early Career grant, which included significant funding for equipment to be used by her graduate students and in active tectonics classes. Professor Blisniuk is resubmitting a modified version of this proposal.

4) Work with Dean to Prioritize New Hires
Three new hires have been made since the 2012 Program Review. The hires in Neotectonics (Blisniuk) and Sedimentology/Stratigraphy (Portner) followed the priorities listed in the last review and the most recent hire in Paleontology (Pietsch) was a replacement for an unanticipated resignation.

5) Actions in Response to Dean’s and External Reviewer’s Recommendations
The Dean and external reviewer Karen Grove (San Francisco State) urged us to simplify and clarify the Department Program Learning Objectives (PLOs). We kept the essential aspects of the PLOs, but eliminated one and revised several others (see section 6.4).

3. Program Descriptions
3.1 Program Mission and Goals
The Department does not have a mission statement, but adheres to the sentiments of the COS Mission. In particular, we strive to: 1) prepare students for rewarding careers in the geological sciences; 2) enable all undergraduate students to achieve a well-rounded education by attaining the quantitative, critical thinking, and scientific skills necessary for lifelong learning and informed decision-making on scientific issues; 3) foster high levels of student learning and faculty development by encouraging and supporting individualized undergraduate and graduate inquiry-based research and scholarship; 4) provide quality lower division core GE and SJSU Studies Area R courses and a service
class for CEE majors; and 5) prepare future K-12 teachers with the appropriate geological background for teaching Earth Science in California’s and the nation’s classrooms.

In a day-long retreat to discuss our program plan, we first considered what constituted our core values. A brief summary of the major conclusions is that: 1) we care about our students, both as individuals and in their success and future career opportunities, and strive to create an environment conducive to student and faculty success; 2) we judge that field-based experiential learning, including numerous field trips and our capstone month-long field course (“field camp”), is critical for our student’s development; 3) we value teaching and faculty and student research (both undergraduate and graduate); 4) we have high expectations for the quality of M.S. graduate research leading to a publication-quality thesis; and 5) we believe in collegiality and contributing to governance at the Department, College, and University levels.

As noted by former Dean Parrish in his response to our last program plan, the Department is characterized by “a strong, cooperative faculty”. When a task needs to be done, all members of the Department contribute to what needs to get completed.

3.2 Summary of Degrees, Minors, Certificates and Service Courses

The Department offers B.S., M.S., and B.A. degrees, and a minor in Geology. Most of our undergraduate students pursue the B.S. degree. The Department is an important contributor to the Science Education Program, teaches a service class for the Department of Civil and Environmental Engineering, and has extensive offerings in the Core GE and SJSU studies.

B.S. Geology

The B.S. degree is designed to increase students' understanding of the Earth, to continue their education toward advanced degrees in the Earth sciences, and to obtain rewarding career employment. The curriculum prepares students for entry-level positions in geological, environmental, engineering, digital mapping, and regulatory firms, and in local, regional, and state government agencies.

The B.S. curriculum follows the Traditional Core Curriculum as defined by Drummond and Markin (2008) in their analysis of approximately of 300 B.S. programs in the U.S. This curriculum is defined by a broad education in the geological sciences and allows room for a student to take upper-division electives, as well as requiring classes in other sciences and mathematics (Drummond and Martin, 2008). Our 120-unit B.S. curriculum consists of a required core of 30 units, including: two introductory (8 units) classes (Geol 1 and 7); a 1-unit lower-division field experience (Geol 028); seven required (21 units) upper-division courses (Geol 100W, 120, 122, 124, 125, 129A, and 129B or 129 C); 22 units of upper-division Geology electives; two semesters of chemistry (Chem 001A and 001B), two semesters of physics (either Phys 002A and 002B, or 50 and 51), and one semester of calculus (Math 30). Core GE and SJSU Studies constitute the remaining units. All of the required and elective upper-division courses have Geol 001 and 007 as prerequisites. The capstone field course, which is taught on a modular basis as Geol 129A and 129B or 129C, has all of the required courses as prerequisites.

More information on the curriculum is given in section 9.4, including: 1) the complete list of courses and required units constituting the major degree program; 2) a 4-year major- and subprogram roadmap for freshmen; 3) a 2-year major- and
subprogram roadmap for transfer students; and 4) a list of courses and required units constituting the major.

B.A. Earth Science

This degree provides a broad background in the Earth Sciences. It is a path for students planning on teaching science in middle schools and high schools, or are interested in interdisciplinary fields such as environmental and sustainability issues. The curriculum requires 16 units of core Geology courses, 10-12 units of Geology electives, classes in Astronomy (6 units), Chemistry, (10 units), Physics (8 units), Meteorology (3 units), and Mathematics (5 units), and other university electives (24-25 units). Very few students take the B.A. option and we intend to revise the degree significantly to make it more relevant and attractive to students (see section 5.1).

Minor in Geology

The minor allows graduates to supplement their major degree program with a broad understanding of the Earth sciences and the principles of scientific investigation. The minor has been updated since last program review; it used to consist entirely of GE classes, but minors now take the 1-unit Geol 028 field experience and one of the upper-division major classes that has an associated lab section. The minor needs to be advertised more to GE students to increase awareness of this option.

M.S. Geology

The M.S. degree in Geology prepares students for professional scientific positions with industrial concerns, governmental services, educational institutions, and Ph.D. programs. The curriculum provides graduates with advanced training in geology, culminating in the completion of a required independent research thesis project. The curriculum and extensive faculty expertise provide the opportunity for study in many areas of geology.

Science Education

The Department offers courses in teacher preparation at the undergraduate (Geol 103) and graduate (Geol 204) levels, and two of our faculty members (Messina and Metzger) have split appointments with the Science Education program. Geol 103 (Earth Systems and the Environment) emphasizes active learning and guided inquiry, and is recommended for students preparing for the multiple subject credential. Geol 204 is entitled “Earth Systems Science for Teachers” and provides potential K—12 teachers with relevant background in Earth Science.

Metzger and Messina have had leadership positions in the College Science Education program and Metzger is the current program director. Metzger and Lecturer Teruya are co-directors of the Bay Area Earth Science Institute (BAESI), a long-standing, highly successful program hosted by the Department. BAESI provides professional development in the geosciences for local teachers, and since 1990, it has served over 3000 teachers via one-day workshops and field trips, and multi-week workshops.

Service to the Department of Civil and Environmental Engineering (CEE)

Geology 002 (Geology for Engineers) serves approximately 150 to 250 CEE students each year. This course has been taught since 2013 in response to a request by
CEE to offer a course to help their department meet an accreditation requirement. This class was designed and has been taught mostly by one of our best and most experienced lecturers who meets with the Chair of CEE once a year to discuss how the curriculum meets the needs of the students. The course provides a foundational knowledge of geology for CEE majors, and required field trips highlight the intersection between geology and civil engineering in identifying landslide, earthquake, and flood hazards. Students also learn to identify common methods of mitigating these hazards and to evaluate their effectiveness.

General Education

The Department of Geology has long had a major role in the GE Program. Earth Science, because of its breadth, highly interdisciplinary nature, and societal value, is well suited to meet a wide range of GE objectives. Core GE classes include those in Areas B1, B2, and B3, and Area E, and recent enrollments have been more than 1400 students a year. The subjects of our upper-division geology GE classes are ideal for addressing the learning objectives and goals of SJSU Studies, Area R (Earth and Environment), and approximately 1,000 students take our courses each year. Three of the Area R classes (Geol 105, 111, 112) have on-line sections. These courses are recognized for their quality across the campus and the ability to provide students with significant learning opportunities in winter intersession and summer sessions, leading to progress on graduation requirements for hundreds of more students each year. The GE offerings and assessment are discussed in more detail in Section 8.1.

List of GE Courses
Core G.E.

Area B1. Geol 001, Geol 003, Geol 006, Geol 007, Geol 009
Area B2. Geol 008
Area B3. *Geol 001, Geol 004L, *Geol 007, *Geol 009
*Class also meets Area B1 requirement
Area E. Geol 005
SJSU Studies
Area R. Geol 103, Geol 105, Geol 107, Geol 111, Geol 112, Geol 124

4. External Factors, Trends, and Context
4.1 Changes in the external environment, and 4.2 Changes in the field.

Changes in the external environment and in the field overlapped and are described together in the following.

In preparation for these combined sections, the Department faculty members discussed most of the “example questions for the self-study” listed in Table 1 of the Program Plan Guidelines during our retreat and multiple faculty meetings.

California State Policy Changes

The California Professional Geology License is required by law to practice geology in the state. The Board for Professional Engineers, Land Surveyors, and Geologists is responsible for licensing and setting regulations. The Board has been in the process of defining the minimum curriculum necessary in a geological sciences degree to obtain licensure as a Professional Geologist, and as part of this process, the Board has been conducting public meetings and workshops with a variety of stakeholders. The
conclusions of this process are summarized as follows. “The fundamental core skills required to be a competent geologist have remained remarkably unchanged over the last 50 years. Basic geologic skills apply across industries and through time, even as specific job tasks have changed, and as technologies/tools have evolved. A lot of the confusion is due to thinking that “core skills” are the same as “industry job tasks” or “technology/tools”.” [https://web.csulb.edu/depts/geology/documents/geology-license-laurie-racca.pdf](https://web.csulb.edu/depts/geology/documents/geology-license-laurie-racca.pdf). The traditional core curriculum for our B.S. Geology (see section 3.2) thus serves our students’ well for licensure.

The California Sustainable Groundwater Management Act (SGMA) was enacted by the state legislature in 2014. It requires that all major groundwater basins be managed in a sustainable manner, which is a significant change from having most groundwater basins un-managed. This act has already created, and should continue creating, a number of jobs for geologists (particularly hydrogeologists) as management agencies are formed, must acquire the necessary management data, and must actively begin managing the basins on a 2020-2022 timeframe.

*Trends*

The job market for B.S. and M.S. geology graduates is healthy, and we have received considerably more inquiries from employers in the Bay Area than there are graduating students. This mirrors national trends, as the demand is in accord with the societal relevance and the fundamental role geological sciences play in a globalized, high technology society (Natural Research Council, 2011). There is a sizable workforce gap between supply and demand of geologists in the U.S., reflecting factors such as environmental issues and natural hazards, and retirement of a generation of geologists (Gonzales and Kean, 2010; U.S. Bureau of Labor Statistics).

The oil and gas industry has traditionally been an important driver of employment in the geological sciences. Much of this employment is in Texas and adjacent states, and only one of our graduates in the last five years is employed in this sector. Nevertheless, the perception of the health of the job market in the geological sciences is influenced by this industry. The American Geosciences Institute (AGI), the nonprofit federation of 51 geoscientific and professional organizations that represents geologists and other Earth scientists, publishes an annual review of trends in employment of recent graduates in the geosciences. In the “Status of Geosciences Graduates 2016” report, they noted that the environmental services industry is a very viable industry for graduates with 31 percent of bachelor’s graduates obtaining a job entering into that industry, and this industry also increased hiring at the M.S. degree level. We suspect that this percentage is significantly higher in California given our numerous environmental hazards and regulations. In comparison to the AGI summary, the largest numbers of respondents to our alumni survey employed in geology are in government (e.g., U.S. Geological Survey, Santa Clara Valley Water District). The next highest group of respondents are educators (university professors, community college instructors) or work for environmental consulting firms. Other alumni are employed in engineering geology consulting, the petroleum industry, K-12 education, mining, or other geology positions.

During our discussions we identified the following factors as likely to increase in importance to society and in employment opportunities for students: geohazards; natural resources; energy management; policy technology and geosciences; and climate science and politics. Natural geohazards, including earthquakes, landslides, floods,
environmental degradation, surface and groundwater contamination, and volcanism, are affecting more people as population density increases and climate changes, and it is imperative to better characterize and mitigate these risks. For example, in the Bay Area and California as a whole, despite relatively strict regulations, building continues in landslide-prone areas, and there is much need of geotechnical support of commercial and infrastructure development. The Department has long had strengths in engineering geology, geomorphology, and hydrogeology, and we are poised to help mitigate many of these hazards. Our recent initiative in active faulting, marked by the hiring of Professor Blisniuk and the addition of an undergraduate and graduate course on these topics, should lead to additional employment opportunities for B.S. and M.S. graduates in earthquake-prone California. The Department has long-standing expertise and numerous graduates employed in understanding and protecting groundwater resources, but does less with other natural resources. Energy management, policy and technology, and climate science and politics are not a focus of our curriculum, but we plan to address these issues with a modified B.A. degree curriculum (see Section 5.1).

In terms of the curriculum and future career opportunities, the importance of the balance between field and laboratory expertise was explored at some length by the faculty. The 2016 AGI report on graduating geology B.S. and B.A. students emphasizes that field skills are essential for their education and training for the workforce. This report noted that since 1996, participation rates in field camp (equivalent to our Geol 129) have increased dramatically and that because of this overall increase, many employers expect graduates to have the necessary field skills developed through a field camp course. The senior registrar (Laurie Racca) for licensing at the California Board for Professional Engineers, Land Surveyors, and Geologists has also stated that the leading reason for denial of a Professional Geologist application is insufficient field experience. The Department is thus well suited to continue to provide the necessary background for employment. The faculty judge, however, that our students’ field experiences should be complimented by the use of new technologies, as described below.

We envision that there will be an increase in job opportunities for our graduates utilizing a variety of new technological tools over the next 5-10 years. Advances in the use of remote sensing are particularly likely to lead to more employment. Most of our B.S. students take our GIS course (Geol 137) and GIS is now routinely used in the M.S. thesis research of Geology students. This background is already helping students to get non-traditional geology jobs, and several of our recent B.S. graduates are now employed by Apple mapping while another works for a local company developing drone technology for a variety of field applications. The use of drones is becoming routine in field research, such as that already done by M.S. students conducting thesis research on active faulting.

Maintaining strong undergraduate (Geol 137) and graduate (Geol 237) courses in GIS and GPS is a priority for the Department. We note that Professor Messina is now in the third year of her FERP status and a priority will be to hire faculty with expertise in GIS. One of our junior faculty members (Portner) included a GIS component in our capstone course in Field Geology (Geol 129) in 2017 and we anticipate that this component will significantly enhance our students’ preparation.

Research

The Department faculty members are proud of our collective research. During the five-year review period faculty published 54 papers and one book, were authors on 134
abstracts for professional meetings, and received $3,968,000 from 28 external grants. M.S. and B.S. students were authors on many of these abstracts and some of the journal publications. Faculty were peer reviewers for a wide range of journals and grant organizations, and three faculty have been, or are currently serving as, associate editors for international journals.

We anticipate that research activity will increase over the next program-review cycle as our newer, very energetic faculty develop their classes and research programs, and new faculty join the Department. Undergraduate research experiences should also increase significantly. Anticipated reduced teaching loads for research-active faculty is another likely catalyst for enhanced research.

Challenges for research are also likely to emerge. Many universities with terminal B.S. or M.S. degrees have increased expectations of faculty to raise external funding, but in the short term, federal research budgets are likely to remain constant (adjusted for inflation) at best. This appears to be the case for NSF, the main federal funding agency for geology. In contrast, if faculty members receive grants with class buyout, this may result in problems in coverage of the curriculum. Insufficient equipment and staff support for research are also hindrances to research, as is the challenge of maintaining a high-quality research program involving graduate students in an area with a very high cost of living. This is particularly problematic for out-of-state students who otherwise are interested in SJSU because of the international reputations of some of the faculty.

During the next program planning cycle, changes are likely in the types of research conducted in the Department. For many years, the Department marketed itself as having strengths in two broad areas – applied geology and tectonics. This is no longer the case, as turnover in faculty and changes in the science over the last decade have led to a wider range of research. We currently have some faculty members who collaborate closely and this is beneficial to their research and that of their M.S. students. For example, two faculty members have shared three multi-year NSF grants, been co-authors on numerous papers, and worked closely with each other’s students. We hope that such rewarding collaborations continue as the Department evolves.

**4.3 Trends in entering student characteristics**

Very few of our B.S. or B.A. graduates enter SJSU or a community college as declared geology majors (see Section 7.1 in Data Elements), and meaningful statistical analysis is very difficult. This mirrors national trends, as the 2016 AGI student summary revealed that only 27% of B.S. and B.A. graduates, and 17% of M.S. graduates, had chosen geology before beginning college; in part this reflects the lack of awareness of geology by entering students, as only approximately 50% of graduates had an Earth Science class in high school. Nationally, 13% of B.S. graduates and 17% of M.S. graduates reporting their ethnicity are from underrepresented groups (AGI, 2016 Report). Females accounted for 48% of B.S. and B.A. graduates nationally.

Geol 120 (Mineralogy) is typically the first class after the introductory courses taken by most majors and does not have GE students. In the cohort this year (2017-18), 27% (not counting females) of the students are identified as from underrepresented groups.
5. Strategic Direction for the Program(s)

5.1 Changes to the curriculum and delivery of the program(s)

B.S. Degree in Geology

The requirements for the B.S. degree have been changed incrementally since the curriculum was overhauled in the early 2000s in part to make it more flexible for students and to decrease the time to graduation, particularly for transfers. In this overhaul, the number of required courses was reduced, sequencing of classes and prerequisites were reduced, as were units to meet the 120-unit requirement. We are pleased overall with the curriculum and have not discussed making major changes. The main changes we foresee before the next program plan review are in the increase in digital mapping associated with the capstone field course (Geol 129), as mentioned in sections 1 and 4.2.

B.A. Degree in Earth Sciences

The B.A. Degree in Earth Science has attracted few students in recent years. The curriculum for this degree was designed in part to prepare K-12 teachers in the Earth sciences, and served to document subject matter competency for a single subject credential in science with a geoscience concentration, but because of changes in K-12 teacher requirements the degree no longer serves this purpose. We discussed the degree during the Program Plan review and decided to increase its relevance and quality by changing some of the curriculum and emphasis of the degree.

The main envisioned modification of the B.A. degree is to focus it on Earth System Science and Sustainability. Earth System Science utilizes an integrative approach to understand the interconnected systems and processes that have driven Earth’s evolution over time and continue to function today. It has become increasingly valuable for interpreting interactions between the cosmosphere, lithosphere/geosphere, atmosphere, hydrosphere and biosphere. The primary actions to incorporate the systems approach in the B.A. degree will be to develop a capstone, four-unit course on Earth System Science and broaden the electives for the degree. The capstone course would further serve as an elective for the B.S. Geology degree.

The faculty discussed the development of two tracts for this degree. One tract would be closer to the current B.A. degree, but broad enough to accommodate both teaching candidates and other interested students. The second tract would focus on Sustainability. It is envisioned as a science and policy tract, and includes electives from Environmental Studies and Political Science. These discussions are ongoing, and Professors Metzger and Pietsch have taken the lead in providing outlines for the Earth System Science course and the potential required and elective courses for the modified major and tracts. We have also discussed making this a B.S. degree. Our plan is to further discuss degree modifications in fall 2018 and submit a new course proposal for the capstone class to the College of Science Curriculum Committee in fall 2018 and the B.A. degree change to the same committee in fall 2019. The intent is to have the modified degree implemented in fall 2020.

M.S. Degree in Geology
We are pleased with the current curriculum in the graduate program. Each graduate class is generally offered on a biennial basis and updated to reflect new discoveries in the discipline. Geol 255 also allows for flexibility in the offerings.

5.2 Faculty Recruitment and Development

Over the last review period, the number of tenured/tenure-track faculty has fluctuated and is now at 10 positions, down from earlier years. Two of these faculty members (Messina and Metzger) have split appointments with Science Education. Messina is on the FERP, as is Professor Oberdorfer, effectively reducing the Department to 8.25 FTEF. Professor R. Miller will go on the FERP in fall 2018 and Professor Reed will do so in the next few years. The Department thus anticipates the need to replace at least four faculty members in the time period before the next Review. The Department has prioritized four critical areas of expertise, listed in order of priority below. The exact sequence of hires depends on the timing of retirements and participation in the FERP.

**Hydrogeology**—A hydrogeologist is the highest priority for a new faculty member. Hydrogeology is critical for California given the extensive use of groundwater for drinking water and the problems of groundwater pollution (e.g., Silicon Valley has one of the nation’s highest densities of EPA Superfund Sites). Our current hydrogeologist, Professor Oberdorfer, has supervised numerous M.S. Geology theses and helped countless undergraduate and graduate students in obtaining employment in environmental and engineering geology consulting firms and the Santa Clara County and Alameda County Water Districts.

**Structural Geology**—An individual who can teach structural geology (Geol 125 and Geol 231) and tectonics (Geol 127), and take a leading role in the field geology program (Geol 129A, B, C) is critical for the curriculum. Structural geology (Geol 125) is a key component of our core for the major and field geology (Geol 129) is the capstone experience. This person would also be important for our incorporation of digital mapping and GIS in field classes. Professor R. Miller is our current structural geologist, and has taught the field course on a regular rotation for more than 30 years. He will enter the FERP in fall 2018. Miller has also supervised a large number of M.S. theses and we anticipate that this field will continue to be in demand after his retirement.

**Low-temperature Geochemistry**—A position in low-temperature geochemistry is our highest priority for a sub-discipline not currently covered by the faculty. This person would preferably be someone in critical zone geochemistry, paleoclimate, and/or watershed hydrology, to expand into an area of growing demand in the Earth Sciences. The critical zone encompasses the near-surface Earth extending from the vegetation canopy down through the zone of circulating fresh groundwater. Soil biogeochemical processes are of major importance for society and this position fits in well with our desire to modify the B.A. degree to give it more of an Earth Systems Science emphasis.

**Geodesy**—A geodesist would fill a position to cover a dramatically growing field in the Earth Sciences. Geodesy involves accurately measuring the geometric shape of the Earth, its orientation in space, and its gravity field, as well as the changes of these properties with time, primarily through the use of satellite data (e.g., GPS, InSAR). A person in this field would strongly enhance our digital mapping initiative, be able to collaborate with other department faculty (e.g., in active tectonics and structural geology), and help out with instruction of Geol 137 (GPS/GIS) and Geol 237 (Advanced GPS/GIS) after Professor Messina ends her participation in the FERP. This person will
also meet our need in the curriculum in geophysics (Geol 147) with the anticipated retirement of Professor Reed before the next Program Plan.

The Department has been successful (and very fortunate) in our last three searches, but had difficulties in hiring before then due to the high cost of housing in the San Jose area, the heavy teaching load, and the limited start-up packages. An increase in starting salary and start-up funds would greatly enhance our ability to recruit.

Several other significant challenges await future and recently hired faculty. As the University increasingly promotes RSCA, the time required for teaching and other parts of the faculty assignment have not decreased. Teaching remains the prime consideration for tenure and we are concerned that expectations for new faculty may not be clear and will become unrealistic. If the College moves to a 9-unit load for research-active faculty this would clearly help recruit faculty and prevent burnout. More attention should also be given to mentoring of new faculty.

Part-Time Lecturers
The Department is fortunate to have high-quality lecturers. The lecturers with the highest teaching loads have taught in the Department for 8 years or more. Since the last program review, one long-term lecturer retired and another resigned. After a transition period, we hired two lecturers who have done very well. The contributions of the lecturers are impressive and include writing a textbook used in Geol 107 and 007, giving multiple oral presentations with abstracts at national professional meetings in Geology and Earth Science education, participating in NSF-sponsored workshops on leading teacher-training sessions, and participating heavily in interactions with the community, such as acting as science fair judges and presenting at career fairs. One part-time instructor has been actively involved in projects to increase the participation of under-represented groups in the geosciences. The lecturers face the same difficulties in housing and most of them work at other positions (e.g., yoga instructor, tutor, part-time consulting).

5.3 Department Initiatives to Enhance Student Success

Undergraduate Research
Undergraduate research in Geology has increased in the last five years, and the faculty plans to significantly enhance the opportunities for research. Some of this research has led to B.S. theses, which are required for Honors in Geology. The achievement of Honors also requires a 3.5 GPA in Geology, and an oral presentation at the Department speaker series. Before 2012 only one student had completed a thesis and received this recognition. From 2012 to 2017, four students graduated with Honors and many more have carried out research with faculty in the Department. The three recent additions to the faculty are enthusiastic about undergraduate research and between them are supervising 7 undergraduate research students. An impediment to undergraduate research is the minimal credit (0.33 WTU) to faculty for this important, but very time-consuming supervision.

Tutoring and Advising
The Department has a robust advising program, which requires students to meet “one-on-one” with the faculty undergraduate advisor each semester. Some of our majors, however, need more tutoring and we plan on hiring in fall 2018 one or two of our top senior majors and/or M.S. students to help students.
5.4 Staff and Resource Implications

The Department has two technicians (Smith and Odisho) and an officer manager/administrative analyst (Blum). The technicians are very conscientious and overworked, and their workloads have increased steadily as our FTES have increased by approximately 47% since its low in 2009-2010. Smith spends large amounts of time handling IT, finances, and logistics. In addition, she supplies IT support to other departments in the COS, and is supervised by the head of the COS Network and Computer Service. Some of her duties need to be assigned elsewhere to relieve her from doing a significant amount of unpaid overtime. It would also help if specific hours were designated for her to work in Geology and others in the COS. Odisho spends much time supporting faculty and graduate teaching assistants in preparation of labs and gear for field trips, and maintaining our aging equipment. His time working on safety has gone up significantly because of new County and State regulations. Both technicians are heavily involved in preparing field equipment and helping out with logistics for the split-session Geol 129A and 129B/C field courses. A paid student assistant has partially eased the double workload on Smith and Odisho, but their time commitment is still significant. In addition, the office administrator position in Geology was cut during the last recession from full to half time, before the large increase in FTES. The number of graduate teaching assistants and graders has also increased significantly, and Blum has to train more student assistants to help run the office. This growth has led to a significantly increased burden on the office administrator. Our preferred solution is to have Blum and Smith work full-time in the Department.

Equipment

Teaching and faculty and student research are hampered by insufficient digital mapping equipment and software, and the lack of major analytical equipment.

The current enrollment limitation in the popular GPS/GIS courses (Geol 137 and 237) is predicated by the number of available mapping-grade instruments. Unlike most GIS classes, Geol 137 and Geol 237 were designed to include a mapping component, in which students create their own GIS datasets. To accomplish this, we need more sub-meter Digital GPS GIS dataloggers, a Trimble total station, and GIS Software. Some of these instruments would also be used in active tectonics classes (Geol 143 and 255) and the capstone field course (Geol 129).

The lack of analytical equipment commonly requires faculty and undergraduate and graduate students conducting research to travel to other facilities to perform analyses. Major equipment needed by the Department for teaching and research includes a research-grade X-ray diffraction machine, a desktop X-ray fluorescence machine, and a table-top scanning electron microscope. This equipment would be used in Geol 120, 122, 135, 142, 213, 214, 242, and certain 255 classes.

Equipment used regularly in instruction as well as in research that needs upgrading or replacement includes microscopes, hand-held GPS units, and computers for the computer lab. Additional items that would benefit instruction and research include seismic data processing software, updated groundwater modeling software, a flow-through water-quality cell with sensors, and other updates for software.

With assistance from the College of Science, the department has purchased and will soon take delivery of two new Suburbans to add to the two Suburbans we have currently. These vehicles are essential for our degree programs and are used in many undergraduate and graduate courses during the academic year, and also for the summer
field camp. However, our two older Suburbans are near the end of their useful life as they were purchased more than 15 years ago. Two Suburbans are the minimum number for us to effectively run our degree programs, and they are inadequate for our summer field program, particularly with the new restrictions on use of College of Science truck (we are no longer allowed to use it for field camp).

6. Assessment of Student Learning in the Program

6.1 Program Learning Objectives (PLO)

B.S. Geology

Students who earn a B.S. Geology degree will possess the ability to:
1. Develop the skill to read and accurately interpret topographic and geologic maps.
2. Effectively communicate scientific ideas and results in writing.
3. Use the fundamentals of chemistry, physics, and math to solve geologic problems.
4. Classify and identify geological materials, such as minerals, rocks, and fossils, and understand their relationships to each other and interacting earth systems.
5. Visualize and comprehend geologic structures and processes.
6. Understand how geologists measure deep time and reconstruct earth history.

6.2 Map of PLOs to University Learning Goals (ULG) - see table under 6.3.

6.3 Matrix of Courses to PLOs.
The following geology courses focus on enhancing the student’s abilities toward each respective PLO. Courses marked with an asterisk are used for assessment.

<table>
<thead>
<tr>
<th>PLO #</th>
<th>Introductory</th>
<th>Reinforcement</th>
<th>Capstone</th>
<th>University Learning Goals §</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GEOL 1, 7, 28</td>
<td>125*</td>
<td>129*</td>
<td>#1</td>
</tr>
<tr>
<td>2</td>
<td>GEOL 1, 7, 28</td>
<td>120, 124*</td>
<td>129</td>
<td>#3</td>
</tr>
<tr>
<td>3</td>
<td>GEOL 1, 7</td>
<td>120*, 122*, 124, 125</td>
<td>129</td>
<td>#1, #3, #4</td>
</tr>
<tr>
<td>4</td>
<td>GEOL 1, 7, 28</td>
<td>120*, 122*, 124*, 125</td>
<td>129*</td>
<td>#1, #3, #4</td>
</tr>
<tr>
<td>5</td>
<td>GEOL 1, 7, 28</td>
<td>122*, 124*, 125*</td>
<td>129</td>
<td>#1, #3</td>
</tr>
<tr>
<td>6</td>
<td>GEOL 1, 7, 28</td>
<td>124</td>
<td>129*</td>
<td>#1, #2, #3, #4</td>
</tr>
</tbody>
</table>

*Course used for assessment of PLO

§University Learning Goal #5 is addressed through GE offerings. Within the B.S. Geology degree, Geology 1 and Geology 7 have assignments that address University Learning Goal #5.
6.4 Interpretation of Assessment Results and Subsequent Actions

After the comments of the external reviewer Grove and Dean Parrish in the 2012 review, the PLOs were modified as follows. PLO #2 (old). Grove recommended eliminating this outcome, and we concurred. PLO#3 (old). Grove also recommended getting rid of the verbal communication part of PLO#3 (now PLO#2), and we agreed. PLO#6 (old). We decided that this PLO (now PLO#5) was cumbersome, so we took out the words "in 4 dimensions (3D plus time)". PLO#6 (new). An essential PLO that was not explicitly addressed in the previous version is the measurement and understanding of geologic (deep) time; as this underpins all of Earth Science, we thought it merited its own PLO. We have much content in the core curriculum to assess this new objective. PLO#7. Grove recommended getting rid of PLO#7, and we deleted it and folded some aspects of this PLO into an expanded PLO#5 (now PLO#4).

During the review period, we formally assessed four of the B.S. PLOs and addressed the WASC Program Outcome Rubric. The Department devoted significant parts of faculty meetings in the spring 2013, 2014, and 2015 semesters to discuss assessment. We went over the assessment reports for the specific PLOs evaluated each of those years (#2, #3, #4, #6) and then discussed the PLOs in general. A brief summary of our assessment follows and more detailed reports are on the Department website

2. Effectively communicate scientific ideas and results in writing.

The most systematic and thorough assessment of this PLO is in Geol 124. In spring 2013, Geol 124 students researched published scientific literature on individual geological localities that illustrate the characteristics of specific sedimentary depositional environments. Each student presented the results of his or her research in a 5-minute oral presentation to the rest of the class. Each student then wrote a 10-page paper on the same topic as the presentation, improving focus and clarity based in part on the questions asked after the oral presentation. More than 90% of the students demonstrated good to excellent ability to effectively communicate scientific ideas and results in writing. We have kept this arrangement of oral presentations and written papers.

3. Use the fundamentals of chemistry, physics, and math to solve geologic problems.

The most systematic and thorough assessment of PLO3 takes place in Geol 122 (Petrology). In two laboratory exercises, students apply physical chemistry principles to investigate processes that form igneous and metamorphic rocks. In the first lab, students used phase diagrams to describe the melting and crystallization behavior of igneous rocks, and in the second lab students focused on metamorphic composition diagrams, which required them to use chemical analyses for rocks and mineral formulas, and to graphically portray equilibrium mineral assemblages for different metamorphic grades. On these exercises, 11 of 12 students demonstrated a satisfactory to excellent understanding of these principles. No significant changes in the curriculum were made.

4. Classify and identify geological materials, such as minerals, rocks, and fossils, and understand their relationships to each other and interacting earth systems.

The classification and identification of geological materials is most directly addressed in Geol 120 (Mineralogy), which is the first required upper division Geology course taken by B.S. students. Students in this course are expected to identify ~75 minerals based on their physical properties seen in hand sample and on a subset of these minerals using properties observed under the polarizing microscope. Students study minerals based on their classification into chemical groups such as sulfides, oxides,
carbonates, and silicates and each mineral group is presented in the context of its occurrence in common rocks and/or in economically important mineral deposits. In fall 2013, students’ ability to identify minerals was assessed by two quizzes and two comprehensive lab practicals. Most (12 of 14) students demonstrated a satisfactory to excellent ability to identify minerals on the two quizzes. The comprehensive lab practicals proved more challenging with about 70% of students demonstrating an average to excellent ability to identify common minerals in hand sample and approximately 80% showing an average or better ability to recognize minerals under the microscope. The lower scores on the lab practicals may result from students not spending a sufficient amount of time outside of lab to prepare for the lab test.

Mineral identification is reinforced in Geol 122 (Petrology) and other classes. No changes have been made, but we have discussed increasing Geol 120 from 3 units to 4 units, in part because of the large time commitment by students, and because we want them to demonstrate a higher level of competence in mineral identification.

6. Understand how geologists measure deep time and reconstruct earth history.

We utilize the field course (Geol 129) as our broadest assessment tool. It covers all six of our PLOs and is used for assessment of Objectives 1, 4, and 6. The modular course (Geol 129A, B, C) requires students to utilize their previous class work to solve problems, involves both independent work and group collaboration, and encourages creative thinking. As noted by Aitchison and Ali (2007), an extended field course is “an ideal capstone experience for geology majors and is ideally suited for use as an instrument for the summative assessment of student learning.” In Geol 129, a comprehensive geologic report is the primary assessment tool. The report includes rock descriptions, stratigraphy, geologic maps and cross-sections of the map area. Students must identify and classify rock units in their map area. The relationships of the rock units to each other is accomplished by mapping the units in the field and identifying the types of contacts between them (e.g. faulted or depositional). The report is evaluated using a standardized rubric (9.4 that assesses how well students perform on each individual part of the report as well the writing. In fall 2013, 7 of 14 students were good to excellent in meeting the PLOs, and 6 were satisfactory to good.

We did not significantly change the curriculum or pedagogy in Geol 129, but changed the sequencing of the course. Beginning in spring 2016, Geol 129 was taught as a 2+(2 or 4) unit sequence with all students taking an introductory 2-unit section (Geol 129A) in the spring. This is followed by the summer course where students can earn either 2 or 4 units of additional credit toward their degree, depending on whether they complete 1 or 2 major geologic mapping projects and accompanying reports. For 2013 - 2015, students had the option of skipping the introductory 2-unit section, which resulted in an uneven field background in the summer. Four units of Geol 129 are required for the BS degree and 2 more units may be counted as Geology elective units.

WASC Program Outcome Rubric

In the 2012 Program Plan, the different elements of the WASC Rubric were either emerging or developed (see 9.6). The followed were all ranked as developed: 1) comprehensive list, 2) alignment, and 3) assessment planning. We made progress on these elements by developing grading rubrics (Appendix 9.4). We also developed a rubric relevant to “assessable outcomes”, which had a 2012 status of emerging/developed, and expanded our list of greensheet expectations. The “student experience” was considered
emergent and the weakest element in 2012. A self-evaluation form (see below) on the outcomes and levels of performance for Geol 129 (which addresses all of the PLOs) was given at the end of the semester in our efforts to increase the status of the “student experience” from emerging to developed. Subsequent to the 2012 review, our top undergraduate major was hired as a tutor for majors classes. This tutor was supported by a grant, and after funding ended, we no longer provided this student support. We do plan to hire a tutor, however, using Department funding in fall 2018.

Self-Evaluation Form
Geology Program Learning Objectives – Evaluation
Geology 129 (field camp/capstone experience) students: The Geology Department wants your feedback on how well you judge that you have achieved one of our Program Learning Objectives (all are listed on the Greensheet).
Objective: Represent and interpret Earth history through deep time.
Please write your comments anonymously on this page and give the survey to the Department Office Administrator.

6.5. M.S. Geology Program Learning Objectives
1. Formulate scientifically sound and logistically reasonable plans for solving geologic problems.
2. Apply the appropriate techniques to acquire and interpret data to arrive at scientifically sound conclusions.
3. Demonstrate scientific writing of acceptable quality.
4. Demonstrate the ability to present results of scientific research in oral format.

The M.S. Geology objectives are assessed primarily through the required thesis and research associated with it. Research preparation includes a thesis proposal, which is typically ca. 10 pages of text, and is accompanied by an oral exam with the student’s thesis committee. Writing is also evaluated in multiple classes that meet the University writing requirement (GW AR). A final thesis defense given to the Department at the weekly speaker series enables assessment of the research by the larger geology community.

The high quality of the theses produced by our students is widely recognized across campus. In the last five years, a thesis from the Department won one of the Best Thesis awards for the University, and students from the Department have received this recognition nine other times, the most of any department in the University to our knowledge. The Graduate School has never rejected theses submitted by our students, and required modifications are minor. Many of our students present their results at regional and national professional meetings. A number of students in the last five years have been authors, along with faculty, on refereed publications, which have incorporated thesis research.

One problem that had arisen is that the writing preparation is poor for a few students when starting the graduate program. Following the last program review, a more detailed written “Statement of Purpose” was developed and is now required in the graduate application. Several international students in recent years had great difficulty in writing and some dropped out because of frustration over trying to satisfactorily write the required thesis. As a result, the Department now requires higher TOEFL scores than the University minimum. It is difficult to assess the efficacy of these changes; the
acceptance rate has not changed significantly and there have been very few international applications.

6.6 Longer Term Indicators of Student Success

Alumni work in numerous geological (engineering and environmental) consulting firms primarily in California, and are owners of a number of small to medium-sized companies, including an independent oil company. Graduates are also employed by numerous government agencies, including the U.S. Geological Survey, California Geological Survey, Santa Clara County Water District, Environmental Protection Agency, Lawrence Livermore Laboratory, U.S. Army Corps of Engineers, and U.S. Forest Service. Other graduates work as K-12 teachers.

Alumni are professors of geology at Penn State University, Utah State University, Cal Poly-San Luis Obispo, Texas Christian University, University of Alabama, University of Alaska-Anchorage, University of Oklahoma, and the Institute for Earth Sciences, Academia Sinica, and at least five alumni are community college instructors in California.

In the last 5 years, our M.S. graduates have received Ph.D. degrees from departments that are rated in the top 20 for Geology in the country. These include MIT (two students), Stanford (one graduated and another currently pursuing the Ph.D. degree), and the University of Wisconsin. In addition to these institutions, our B.S. and M.S. students in earlier years have gone on to get Ph.D. degrees at Oxford University (U.K.), UC-Berkeley, UC-Davis, UC-Santa Barbara, UCLA, UC-Santa Cruz, University of Southern California, University of Arizona, and elsewhere, and M.S. degrees from many universities in the University of California system and elsewhere, including amongst others, Colorado School of Mines, University of British Columbia, University of Arizona, University of New Mexico, and the University of Colorado.

6.6. Alumni Survey.

A survey of alumni was conducted in October-November 2017 as part of our program assessment. This survey was sent to 224 alumni and 75 responses were received. In addition to specifying the type of degree, year of graduation, type of field(s) employed in, or were employed by, alumni were asked to rate their education and the Department on a 1 (low)-to-5 (high) scale. The results of the survey are briefly summarized here and the unedited responses are in 9.7.

The largest numbers of respondents employed in geology work in government (e.g., U.S. Geological Survey, Santa Clara Valley Water District), followed by educators (university professors, community college instructors) and those working for environmental consulting firms. Other alumni are employed in engineering geology consulting, the petroleum industry, K-12 education, mining, or other geology positions. About a third of the respondents are in non-geology positions.

The list of questions for alumni, average numerical rankings, and unedited responses are in section 9.7. Average ratings for the 5 questions posed to alumni are 4.01, and suggest that alumni value their educations. There is not a large spread in the data. The greatest strengths were viewed as the overall breadth of the education and the attainment of field skills, and the lowest rankings were in the development of quantitative skills and learning applied geology. Written comments were also mostly very positive. A few students would like to see more time devoted to oral presentations and to applied geology.
The responses to the survey on alumni competency in the PLOs was higher, as average scores ranged from 4.15-4.78 and the average was 4.67. We note that some of the alumni respondents graduated before the PLOs were instituted, and our continued emphasis on these objectives suggests that our current students will meet them.

7. Program Metrics and Required Data

7.1 Enrollment, Retention, and Graduation Rates

Overview Statement

In the following analysis, it is difficult to make statistically valid statements because of the low numbers of students. This is particularly the case for freshman, as very few enter SJSU as Geology majors, probably reflecting that few college-bound students are taught Earth Science in high school. Almost all of the Geology majors who started as freshmen transferred from other departments. In a survey of B.S. and B.A. majors in fall 2017, of the 18 who responded, none started as Geology majors. Many were inspired by taking a GE class in the Department or a geology course at a community college.

Trends in new freshmen and transfer enrollments.

Freshmen applications and admissions have increased significantly between fall 2012 and fall 2016, but enrolled students have fluctuated on a percentage basis; 1-3 students typically enroll a year. We plan to make efforts to increase the percentage of accepted students who enroll (section 1). The trends for transfer students are similar. The number of applicants and accepted individuals has increased, although less significantly than freshmen transfers. Enrollees have fluctuated from 3-6 students a year, but the percentage of applicants and admitted students who attend has decreased. The Department hopes to increase the number of enrollees through more interaction with local community college instructors (section 1). Graduate student applications have been relatively constant, whereas admitted student numbers have fluctuated from a high in 2012. The number of enrolled students has also decreased from 2012 to 2016. We speculate that this decrease reflects: the entry into the FERP of two faculty members (Andersen, Oberdorfer) who supervised numerous graduate students; the increase in geology employment opportunities for B.S. graduates; and the high cost of housing in San Jose, which particularly reduces the number of out-of-state students. We predict that there will be an increase in M.S. students, as our recently hired faculty develop their research programs and become more visible to the professional community.

Trends in 1st year retention rates.

The number of students considered is so low that any conclusions are statistically invalid. Percentages range from 0-100% for URM students and 67-100% for non-URM students. The number of transfers is higher than that of freshmen, although a statistical retention rate is still of dubious value. All URM students remained in the University, the program total ranged from 60-100%, and the average was 86% of students.

Trends in graduation rates.

Data for the four-year graduation rate are only available for fall 2009 and 2012, and are both 33%, close to the goal of 35%. For transfer students, the two-year graduation rate is low (17% and 20%) for the two years of data, but higher than the COS average. The four-year rate ranged from 50-80%; the average annual rate is 63%, within the range of the COS. This rate has fluctuated and no clear trends are visible. The low rates may in large part reflect that many of the transfers have not taken the necessary classes in
calculus, chemistry, and physics before arriving here. The Department hosted the local community college Earth Science instructors at a luncheon in 2014 and discussed transfer issues. We plan future meetings (see section 1) and hope that there will be better streamlining of the transfer process. The B.S. is now AS-T (AB1440) compliant, which should lead to faster graduation for transfer students.

The native junior graduation rate is somewhat informative given the number of students who started in other majors. The 6-year graduation rates range from 40-80%, and the average annual rate is 54%. Four-year rates range from 0-25%; the low rates are not surprising given the presumably late start these students had in taking geology and supporting chemistry, math, and physics courses.

**Trends in number of graduates**

The number of total (B.S. and M.S. Geology, B.A. Earth Science) graduates has fluctuated from 11 in 2012-13 to 18 in 2014-15; 12 students graduated in 2015-16.

### 7.2 FTEF, SFR, Percentage T/TT Faculty

The faculty headcount was nearly constant, changing from 30 in fall 2011 to 31 in fall 2016. This headcount includes a large number of graduate teaching associates instructing introductory lab sections. The number of Full-time equivalent faculty (FTEF) also changed little over 6 years and dropped slightly from 12.7 in fall 2011 to 12.0 in fall 2016. The student-faculty ratio (SFR) has increased by 28% from fall 2011 (18) to fall 2014 (23), and dropped slightly from 23 to 22 in fall 2016, but was still 22% higher than fall 2011. The tenure density decreased from fall 2011 and fall 2012, when it was 73%, to 62% in fall 2016.

The relation of faculty hiring and workload practices to the program’s mission, goals, and student outcomes is complex. The decrease in tenure density has put an increased load on tenured faculty, particularly in a small department where all faculty must take on College and Department committee and advising assignments. The faculty have been able to maintain and increase the quality of the program, but it has been challenging to pursue other opportunities. In particular, the heavier workload has made it harder to maintain research activity. Nevertheless the metrics for research productivity (papers, grants, etc.) suggest that the faculty have continued to conduct quality research. More of the duties in the Department have also been done by lecturers. For example, T/TT faculty have traditionally served as coordinators for courses with multiple lab sections, but lecturers have taken on this assignment for classes on multiple occasions.

### 7.3 Additional Program Data Elements

**Migration of Majors.** The limited data indicate that students who were undeclared or engineering majors make up more than three quarters of the graduates in geology. We hypothesize that undeclared students were drawn into the major after discovering geology in one of our G.E. classes. The explanation for the engineering majors is unclear.

**Grade Gap for URM Students.** Four geology classes had statistically significant grade gaps. The gaps were relatively small (3-5%) for three of the courses, which include two G.E. and one service course. The Chair will discuss these gaps with the relevant instructors and we will work to close these gaps. The other class (Geol 142) had a large gap. This class was only offered twice during the period evaluated and the enrollments were relatively small. The professor who taught the class has left the university, and we are uncertain as to the reasons for the gap. A new T/TT hire (Professor Pietsch) is
teaching Geol 142 in spring 2018, and the chair will monitor these rates in consultation with her.

*Enrollment in Minors and Certificates.* After a high of 6, the number of minors has fluctuated from 2 to 4 students over the last 5 years for which there are data. As noted in section 3.2, we suspect that students are not aware of the minor option and it needs to be advertised to G.E. and CEE students. Numerous students have told instructors that they are excited about geology, but are too far along in their studies to change majors, and the minor would provide a viable option. An increased minor pool may also potentially attract new majors.

*Predictors of Graduation Rates.* IEA states there is an “insufficient sample to model”.

*Demand for Courses by College.* The Department draws students from all Colleges in numbers roughly proportional to the size of the academic unit. The FTES from each college has fluctuated, but generally increased as the total Department FTES has gone up. These results are in accord with the major role that Geology plays in the G.E. Program. The most dramatic trend has been in the number of Engineering students, which has increased from an annual FTES of 11 in 2013-14 to a high of 29 FTES in 2015-16. This increase of 163% reflects the CEE degree requirement that their majors take Geology 002, which was fully implemented in fall 2014.

*Average Units on Completion of Undergraduate Degree.* For freshman, as noted above, the number of students is too small for statistically valid analysis. Units ranged from 144 to 149 for the first five years of data, decreased slightly to 141 units and then 121 units in spring 2016. We hope that this overall trend continues. Transfers fluctuated between 155 and 180 units upon graduation for most of the time interval considered. Spring 2017 saw a sharp drop to 140 units. Given that many transfers have taken only one geology class and lack the required supporting science and math classes upon arrival at SJSU, it is not surprising that students take more than 120 units. The increased coordination between community colleges and SJSU, as well as our B.S. now being AB1440 compliant, should lead to fewer units on graduation.

8. Assessment of Student Learning in GE courses, if any

8.1 GE Summary and Reflection

The Department of Geology has a major role in the GE Program. Earth Science, because of its breadth, highly interdisciplinary nature, and societal value, is well suited to meet a wide range of GE objectives. The Department places considerable resources into GE classes, which are taught by tenured and probationary faculty, and experienced lecturers with average to excellent SOTEs and peer evaluations.

The Department has continuously adapted to perceived needs of GE students. We have also studiously followed the GE requirements in terms of class sizes and minimum writing requirements. All classes with multiple laboratory sections have a course coordinator who is a tenured or probationary professor, or long-term (>5 years) lecturer.

GE courses are listed in the following, and comments are made on noteworthy changes in classes since the last program review where applicable.

**CORE GE**

*Area B1* (courses in italics have a required associated laboratory section and also meet the B3 requirement).  
*Geol 001* (General Geology), *Geol 003* (Planet Earth), *Geol 006* (Geology of California), *Geol 007* (Earth, Time, and Life), and *Geol 009* (Earth Disasters).*
A required day-long field trip has been added to Geol 007. During this trip, students apply the knowledge gained in the classroom and lab to directly examine the natural setting. This trip is an excellent experiential learning activity, and has the additional benefits of increasing student interpersonal interactions and group learning, and exposing them to scenic localities. As a result of the success of this field trip, the Department plans to develop required field trips for the other combined 4-unit lecture-lab classes (Geol 001 and Geol 009).

Geol 009 was developed in response to discussions at a Department retreat during our last program planning. The rationale for the course is the need for the public to understand the types and scientific basis for natural hazards. The topics covered in the class are also easily amenable to meeting the B1 and B3 learning objectives.

*Area B2. Geol 008 (Age of Dinosaurs)*

This is a course added since the last program plan. It focuses on evolution and mass extinctions, and capitalizes on the general interest of the public in dinosaurs.

*Area B3.*

The Department offers four laboratory classes (Geol 1, 4L, 7, 9), which meet the one unit Area B3 requirement. In addition to the new offering of Geol 009, Geology 004L has been significantly modified. Geol 004L is unique in the university in that it is not associated with a lecture course and enables students who have taken another 3-unit Area B-1 course not affiliated with a lab (e.g., in Geog, Geol, Met, Phys and Astr) to meet the GE requirement without taking another 4-unit course. The lack of an associated lecture component, however, makes Geol 004L a challenging course to teach, as instructors can only briefly introduce lab material so as to allow students most of the time to be actively engaged in lab learning. As part of our annual GE assessment, the Department recognized that some of the lab exercises could be improved and over the last four years we have steadily revised the curriculum. The overarching goal of these revisions has been to improve conceptual coherence among the weekly lab exercises through use of an Earth systems approach that helps students understand the complex interactions between the geosphere, atmosphere, hydrosphere, and biosphere. We have also expanded consideration of how humans interact with Earth systems. These modifications have been done by lab coordinators Messina and Metzger who are also part of the Science Education Program and have incorporated current active learning practices into the labs.

*Area E. Geol 005 (Human Development and the Natural World).*

This course had not been offered for many years, as the professor (J Miller) who developed the class has had a full load with teaching majors’ classes and administrative duties. We offered the course again in 2016 in response to the needs of Science Education students. It will also become a key class for a new CSU-wide program in Sustainability and a core course in the planned update to the B.A. Earth Science degree.

**SJSU STUDIES**

The Department offers a wide range of courses in Area R (Earth and Environment), including: Geol 103 (Earth Systems and the Environment), Geol 105 (Oceanography), Geol 107 (Prehistoric Life), Geol 111 (Environmental Geology), Geology 112 (Earthquakes and Volcanoes), and Geol 124 (Sedimentology and Stratigraphy). These are long-standing GE courses, which have been taught on a semester or annual basis for more than 15 years. The exception is Geol 124, which was recently approved for Area R, and is also required for the B.S. degree. Three of these courses (105, 111, 112) are taught
online, as well as class room sections. Geol 103 is aimed at students planning on becoming K-12 teachers. Other than Geol 124, these course have been assessed annually by the Department (see attached) and recertified by the Board of General Studies. Changes in these classes have been largely incremental with time.

8.2 Interpretation of Assessment Results and Subsequent Actions
In addition to the summary of modifications of classes described in section 8.1, the annual reports for all of our GE courses (section 9.8) are attached and are on the Department and University website. The exceptions are: Geol 008 and Geol 009, which have only been taught for a few years; Geol 005, which was taught in fall 2017 after a long hiatus; and Geol 124, which was certified for GE credit beginning in spring 2018.

REFERENCES CITED
Drummond, C.N. and Markin, J.M., An Analysis of the Bachelor of Science in Geology Degree as Offered in the United States. Journal of Geoscience Education, v. 56, p. 113-119

Appendices

9.1. Required Data Elements
9.2. Accreditation Report. Not applicable
9.3 Curriculum Flow Charts, and mapping
9.4. Assessment Rubrics
9.5. Student Success Data Summary (from alumni survey)
9.6. Program Review and Response - 2012
9.7 Alumni Survey
9.8. G.E. Reports
Number of units in the program core
As part of program planning, departments need to verify that they are following CSU Executive Order 1071, revised January 20, 2017. In particular, concentration-specific units must be less than half of the total units required for the major. Please see the current SJSU catalog and verify that units of the department’s majors and any concentrations are consistent with the policy.

To review current units in the core, visit the SJSU catalog at info.sjsu.edu
Program Planning—Data Element 2

Applications and admissions

The number who applied, were admitted, and enrolled in state-supported programs by level. The percentage yield from admissions is shown on the right.

<table>
<thead>
<tr>
<th>Term Type</th>
<th>Major</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Admissions</td>
<td>Geology</td>
<td>Geology</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Freshmen</th>
<th>% Admitted Who Enrolled</th>
<th>% Applicants Who Enrolled</th>
<th>Transfers</th>
<th>% Admitted Who Enrolled</th>
<th>% Applicants Who Enrolled</th>
<th>Graduate Students</th>
<th>% Admitted Who Enrolled</th>
<th>% Applicants Who Enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall 2012 Fall 2013 Fall 2014 Fall 2015 Fall 2016</td>
<td></td>
<td></td>
<td>Fall 2012 Fall 2013 Fall 2014 Fall 2015 Fall 2016</td>
<td></td>
<td>Fall 2012 Fall 2013 Fall 2014 Fall 2015 Fall 2016</td>
<td></td>
<td>Fall 2012 Fall 2013 Fall 2014 Fall 2015 Fall 2016</td>
<td></td>
</tr>
<tr>
<td>Freshmen</td>
<td></td>
<td></td>
<td></td>
<td>Transfers</td>
<td></td>
<td></td>
<td>Graduate Students</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14%</td>
<td>25%</td>
<td>17%</td>
<td>7%</td>
<td>14%</td>
<td>8%</td>
<td>13%</td>
<td>4%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>28%</td>
<td>43%</td>
<td>25%</td>
<td>19%</td>
<td>14%</td>
<td>23%</td>
<td>23%</td>
<td>13%</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>71%</td>
<td>89%</td>
<td>88%</td>
<td>85%</td>
<td>86%</td>
<td>55%</td>
<td>44%</td>
<td>50%</td>
<td>30%</td>
</tr>
</tbody>
</table>
Program Planning—Data Element 3

**Migration of majors**
The number of graduates who came to SJSU as freshmen and either started or completed their studies in this program along with their other programs if they changed (cumulative 2009-2013 entering cohorts).

**Freshman in Geology ultimately graduated in . . .**

<table>
<thead>
<tr>
<th>Major</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication Studies</td>
<td>100% (N=1)</td>
</tr>
</tbody>
</table>

The percentage represents freshmen entrants to this major who graduated in the majors shown through summer 2016. Students who did not graduate are not included in this calculation.

**Graduates in Geology originally started in . . .**

- **Undeclared**: 44% (N=4)
- **Engineering**: 22% (N=2)
- **Computer Engineering**: 11% (N=1)
- **Physics**: 11% (N=1)
- **Pre-Nursing**: 11% (N=1)

This percentage shows graduates in this major, through summer 2016, who entered as freshmen in the majors shown. Students who did not graduate are not included in this calculation.
Courses with high rates of D, F, and WU grades

Undergraduate courses in the department with an unusually high percentage of attempts resulting in non-advancing grades. These could represent curricular bottlenecks for students needing these classes.

Classes with highest non-advancing grades (cumulative 2013 to 2017)

No classes in the department had high-failure classes during this period.
Program Planning—Data Element 5

**Courses with grade gap for URM students**

Undergraduate courses in the department with a gap in underrepresented minority (URM) versus non-URM student grades earned. Gaps are shown when the percentage earning a C- or better was statistically significant at $p < 0.01$.

**Courses with significant gaps (cumulative 2013 to 2017)**

<table>
<thead>
<tr>
<th>Course</th>
<th>URM Rate</th>
<th>Non-URM Rate</th>
<th>Gap in passing rate between URM and non-URM students</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 0142</td>
<td>57%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>GEOL 0002</td>
<td>93%</td>
<td>98%</td>
<td></td>
</tr>
<tr>
<td>GEOL 0001</td>
<td>88%</td>
<td>93%</td>
<td></td>
</tr>
<tr>
<td>GEOL 0004L</td>
<td>95%</td>
<td>98%</td>
<td></td>
</tr>
</tbody>
</table>
Undergraduate retention rates

The number of new undergraduates who entered the program and their rate of persistence one year later in any program at SJSU. Additional detail is provided on underrepresented minority (URM) students in the program.

First-time freshmen, full-time at entry

<table>
<thead>
<tr>
<th></th>
<th>URM Students</th>
<th>Non-URM Students</th>
<th>Program Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2012</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>3</td>
<td>67%</td>
<td>67%</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>0%</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>1</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Upper division transfers from CA community colleges

<table>
<thead>
<tr>
<th></th>
<th>URM Students</th>
<th>Non-URM Students</th>
<th>Program Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2011</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Fall 2012</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Fall 2013</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Fall 2014</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Fall 2015</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
Undergraduate graduation rates and goals

Undergraduate graduation rates are shown by level of entry. Students are tracked under their major at admission, but graduation in any SJSU program counts toward the department’s graduation rate.

**Freshman entrants**

- **6-Year Goal:** 71%
- **4-Year Goal:** 35%

**Transfer entrants**

- **4-Year Goal:** 80%
- **2-Year Goal:** 36%

**Fall Years**

- 2006
- 2007
- 2008
- 2009
- 2010
- 2012
- 2013
- 2014
Native junior graduation rates

Rates for full-time freshman entrants from any major who were in this major as of the fifth semester. This view may be informative for undergraduate programs with a large number of incoming changes of major.

Method notes
This version of the graduation rate is similar to a typical freshman cohort rate, only it attributes the credit to whatever major the student held as of the start of the junior year. However, the starting point of the cohort is still the freshman admission term. The graduation is attributed to this major regardless of the ultimate degree major.
Program Planning—Data Element 9

**Enrollment in minors**
Headcount of undergraduates in department minors, if offered.

### Undergraduate minors

<table>
<thead>
<tr>
<th></th>
<th>Fall 2011</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2014</th>
<th>Fall 2015</th>
<th>Fall 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology Minor</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Interpretation**
Counts are shown for declared minors. Note that some students begin taking courses in the minor and only declare it officially when they are close to completion. Some seniors also drop a minor at the end if it could delay graduation.
Faculty size and ratios

Tenure density is for active faculty based on payroll classification. All other measures on this page are based on class/supervision assignments and do not account for leaves and non-teaching assignments.

Student-faculty ratio, faculty headcount, and FTEF

Tenure density (% of payroll FTE in tenure lines)
Predictors of timely graduation
A statistical model of factors that may help explain the likelihood of graduating within six years for frosh who entered this department’s programs and graduated anywhere at SJSU.

Predictors of freshman graduation within six years (any major)

Insufficient sample of incoming students to model

Interpretation
Predictors with a significance level of $p < 0.05$ or lower are likely to represent nonrandom differences in student outcomes. The predictors are sorted from the most positive associations with graduation to the most negative. Predictors labeled as "not sig." were not statistically significant in this model and could be due to random chance. Results depend on having sufficient sample sizes; programs with small frosh admissions may not have any significant predictors.
Program Planning—Data Element 12

Demand for the department’s courses by college

Full-time equivalent students (FTES) in the department’s courses segmented by students’ major college. This can reflect service courses and crossover in requirements or interests between programs.

<table>
<thead>
<tr>
<th>Major College</th>
<th>Fall 2013</th>
<th>Spring 2014</th>
<th>Fall 2014</th>
<th>Spring 2015</th>
<th>Fall 2015</th>
<th>Spring 2016</th>
<th>Fall 2016</th>
<th>Spring 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Sciences and Arts</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>29</td>
<td>27</td>
<td>27</td>
<td>27</td>
<td>23</td>
</tr>
<tr>
<td>Business</td>
<td>44</td>
<td>51</td>
<td>52</td>
<td>63</td>
<td>59</td>
<td>55</td>
<td>47</td>
<td>42</td>
</tr>
<tr>
<td>Education</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>9</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Engineering</td>
<td>11</td>
<td>11</td>
<td>14</td>
<td>22</td>
<td>31</td>
<td>27</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Humanities and the Arts</td>
<td>33</td>
<td>36</td>
<td>33</td>
<td>39</td>
<td>37</td>
<td>37</td>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td>Science</td>
<td>35</td>
<td>34</td>
<td>47</td>
<td>49</td>
<td>54</td>
<td>50</td>
<td>46</td>
<td>38</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>34</td>
<td>37</td>
<td>35</td>
<td>43</td>
<td>40</td>
<td>46</td>
<td>41</td>
<td>39</td>
</tr>
<tr>
<td>Undeclared/Other</td>
<td>27</td>
<td>27</td>
<td>21</td>
<td>24</td>
<td>30</td>
<td>23</td>
<td>21</td>
<td>14</td>
</tr>
<tr>
<td>Total Department FTES</td>
<td>217</td>
<td>230</td>
<td>237</td>
<td>274</td>
<td>283</td>
<td>275</td>
<td>249</td>
<td>220</td>
</tr>
</tbody>
</table>
**Program Planning—Data Element 13**

**Average units on completion of undergraduate degree**

The average cumulative undergraduate units earned at the time the degree was awarded. It includes units transferred from other institutions as well as any units earned that were not required for the degree.

### Frosh

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>149</td>
</tr>
<tr>
<td>2009</td>
<td>144</td>
</tr>
<tr>
<td>2010</td>
<td>148</td>
</tr>
<tr>
<td>2011</td>
<td>149</td>
</tr>
<tr>
<td>2012</td>
<td>141</td>
</tr>
<tr>
<td>2013</td>
<td>121</td>
</tr>
</tbody>
</table>

### Transfer

<table>
<thead>
<tr>
<th>Year</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>179</td>
</tr>
<tr>
<td>2009</td>
<td>176</td>
</tr>
<tr>
<td>2010</td>
<td>186</td>
</tr>
<tr>
<td>2011</td>
<td>172</td>
</tr>
<tr>
<td>2012</td>
<td>155</td>
</tr>
<tr>
<td>2013</td>
<td>174</td>
</tr>
<tr>
<td>2014</td>
<td>177</td>
</tr>
<tr>
<td>2015</td>
<td>180</td>
</tr>
<tr>
<td>2016</td>
<td>186</td>
</tr>
<tr>
<td>2017</td>
<td>140</td>
</tr>
</tbody>
</table>

Averages are shown by year of spring graduation. Fall and summer degrees are not shown here.
## Appendix 1—Frosh Graduation Comparison

### Average frosh graduation rates by college

The percentage of first-time, full-time frosh who entered the college’s majors and finished anywhere at SJSU.

#### Frosh 4-Year Rate

<table>
<thead>
<tr>
<th>Cohort College</th>
<th>Semester of Entry</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Sciences and Arts</td>
<td></td>
<td>42%</td>
<td>47%</td>
<td>43%</td>
<td>46%</td>
<td>51%</td>
<td>57%</td>
<td>63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td></td>
<td>54%</td>
<td>55%</td>
<td>53%</td>
<td>58%</td>
<td>61%</td>
<td>67%</td>
<td>76%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>46%</td>
<td>65%</td>
<td>53%</td>
<td>43%</td>
<td>63%</td>
<td>64%</td>
<td>79%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td>45%</td>
<td>40%</td>
<td>39%</td>
<td>39%</td>
<td>43%</td>
<td>47%</td>
<td>55%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities and the Arts</td>
<td></td>
<td>49%</td>
<td>43%</td>
<td>49%</td>
<td>47%</td>
<td>52%</td>
<td>53%</td>
<td>65%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>43%</td>
<td>40%</td>
<td>43%</td>
<td>46%</td>
<td>46%</td>
<td>53%</td>
<td>60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Sciences</td>
<td></td>
<td>55%</td>
<td>51%</td>
<td>52%</td>
<td>51%</td>
<td>50%</td>
<td>62%</td>
<td>67%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate Studies</td>
<td></td>
<td>48%</td>
<td>47%</td>
<td>49%</td>
<td>50%</td>
<td>54%</td>
<td>57%</td>
<td>59%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJSU Average</td>
<td></td>
<td>48%</td>
<td>46%</td>
<td>47%</td>
<td>48%</td>
<td>52%</td>
<td>57%</td>
<td>62%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Frosh 6-Year Rate

<table>
<thead>
<tr>
<th>Cohort College</th>
<th>Semester of Entry</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Sciences and Arts</td>
<td></td>
<td>42%</td>
<td>47%</td>
<td>43%</td>
<td>46%</td>
<td>51%</td>
<td>57%</td>
<td>63%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business</td>
<td></td>
<td>54%</td>
<td>55%</td>
<td>53%</td>
<td>58%</td>
<td>61%</td>
<td>67%</td>
<td>76%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>46%</td>
<td>65%</td>
<td>53%</td>
<td>43%</td>
<td>63%</td>
<td>64%</td>
<td>79%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td>45%</td>
<td>40%</td>
<td>39%</td>
<td>39%</td>
<td>43%</td>
<td>47%</td>
<td>55%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities and the Arts</td>
<td></td>
<td>49%</td>
<td>43%</td>
<td>49%</td>
<td>47%</td>
<td>52%</td>
<td>53%</td>
<td>65%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>43%</td>
<td>40%</td>
<td>43%</td>
<td>46%</td>
<td>46%</td>
<td>53%</td>
<td>60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Sciences</td>
<td></td>
<td>55%</td>
<td>51%</td>
<td>52%</td>
<td>51%</td>
<td>50%</td>
<td>62%</td>
<td>67%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undergraduate Studies</td>
<td></td>
<td>48%</td>
<td>47%</td>
<td>49%</td>
<td>50%</td>
<td>54%</td>
<td>57%</td>
<td>59%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SJSU Average</td>
<td></td>
<td>48%</td>
<td>46%</td>
<td>47%</td>
<td>48%</td>
<td>52%</td>
<td>57%</td>
<td>62%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2—Transfer Graduation Comparison

**Average undergraduate transfer graduation rates by college**

Rates for upper division transfers from CA community colleges who entered the college’s majors.

### Transfer 2-Year Rate

<table>
<thead>
<tr>
<th>Cohort College</th>
<th>Semester of Entry</th>
<th>Fall 2008</th>
<th>Fall 2009</th>
<th>Fall 2010</th>
<th>Fall 2011</th>
<th>Fall 2012</th>
<th>Fall 2013</th>
<th>Fall 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Sciences and Arts</td>
<td></td>
<td>17%</td>
<td>16%</td>
<td>21%</td>
<td>20%</td>
<td>25%</td>
<td>33%</td>
<td>29%</td>
</tr>
<tr>
<td>Business</td>
<td></td>
<td>21%</td>
<td>21%</td>
<td>27%</td>
<td>22%</td>
<td>21%</td>
<td>25%</td>
<td>27%</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>29%</td>
<td>20%</td>
<td>22%</td>
<td>35%</td>
<td>35%</td>
<td>42%</td>
<td>37%</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>4%</td>
<td>5%</td>
<td>4%</td>
<td>9%</td>
</tr>
<tr>
<td>Humanities and the Arts</td>
<td></td>
<td>11%</td>
<td>8%</td>
<td>12%</td>
<td>14%</td>
<td>16%</td>
<td>19%</td>
<td>14%</td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>4%</td>
<td>5%</td>
<td>6%</td>
<td>4%</td>
<td>15%</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td></td>
<td>26%</td>
<td>29%</td>
<td>37%</td>
<td>35%</td>
<td>43%</td>
<td>37%</td>
<td>42%</td>
</tr>
<tr>
<td>Undergraduate Studies</td>
<td></td>
<td>14%</td>
<td>20%</td>
<td>13%</td>
<td>10%</td>
<td>11%</td>
<td>11%</td>
<td>9%</td>
</tr>
<tr>
<td>SJSU Average</td>
<td></td>
<td>17%</td>
<td>17%</td>
<td>18%</td>
<td>19%</td>
<td>22%</td>
<td>24%</td>
<td>23%</td>
</tr>
</tbody>
</table>

### Transfer 4-Year Rate

<table>
<thead>
<tr>
<th>Cohort College</th>
<th>Semester of Entry</th>
<th>Fall 2006</th>
<th>Fall 2007</th>
<th>Fall 2008</th>
<th>Fall 2009</th>
<th>Fall 2010</th>
<th>Fall 2011</th>
<th>Fall 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Sciences and Arts</td>
<td></td>
<td>58%</td>
<td>58%</td>
<td>67%</td>
<td>68%</td>
<td>77%</td>
<td>76%</td>
<td>77%</td>
</tr>
<tr>
<td>Business</td>
<td></td>
<td>65%</td>
<td>65%</td>
<td>71%</td>
<td>75%</td>
<td>84%</td>
<td>75%</td>
<td>79%</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td>61%</td>
<td>66%</td>
<td>75%</td>
<td>63%</td>
<td>79%</td>
<td>74%</td>
<td>81%</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td>57%</td>
<td>46%</td>
<td>55%</td>
<td>51%</td>
<td>66%</td>
<td>66%</td>
<td>60%</td>
</tr>
<tr>
<td>Humanities and the Arts</td>
<td></td>
<td>56%</td>
<td>50%</td>
<td>58%</td>
<td>60%</td>
<td>60%</td>
<td>65%</td>
<td>68%</td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td>52%</td>
<td>48%</td>
<td>55%</td>
<td>50%</td>
<td>58%</td>
<td>71%</td>
<td>70%</td>
</tr>
<tr>
<td>Social Sciences</td>
<td></td>
<td>65%</td>
<td>64%</td>
<td>69%</td>
<td>74%</td>
<td>77%</td>
<td>77%</td>
<td>80%</td>
</tr>
<tr>
<td>Undergraduate Studies</td>
<td></td>
<td>50%</td>
<td>50%</td>
<td>71%</td>
<td>60%</td>
<td>64%</td>
<td>47%</td>
<td>55%</td>
</tr>
<tr>
<td>SJSU Average</td>
<td></td>
<td>60%</td>
<td>58%</td>
<td>66%</td>
<td>67%</td>
<td>70%</td>
<td>70%</td>
<td>72%</td>
</tr>
</tbody>
</table>

---

#### Notes:

- **SJSU Average** refers to the overall average graduation rate for all cohorts combined.
- **Semester of Entry** indicates the fall semester in which the transfers entered the college.
- **Transfer 2-Year Rate** reflects the graduation rate within the first two years.
- **Transfer 4-Year Rate** reflects the graduation rate within the first four years.
## University Course Requirements

### General Education Requirements
- Includes "Core GE" (lower division) and "SJSU Studies" (upper division)
  - Core GE: 39 units
  - SJSU Studies: 12 units

*Of the 51 units required by the university, 15 may be satisfied by specified major and support requirements. Consult undergraduate advisor for details.*

See [info.sjsu.edu](http://info.sjsu.edu) for a listing of General Education courses.

### American Institutions Courses
- 6 units
  *Of the 6 units required by the university, all may be satisfied within general education requirements as specified in the schedule of classes.*

See [info.sjsu.edu](http://info.sjsu.edu) for a listing of American Institutions courses.

### Physical Education
- 2 units

See [info.sjsu.edu](http://info.sjsu.edu) for a listing of Physical Education courses.

## Major-Specific Course Requirements

### Preparation for the Major
- CHEM 001A and CHEM 001B- General Chemistry: 10 units
- MATH 030- Calculus I: 3 units

Complete one sequence:
- PHYS 002A and PHYS 002B- Fundamentals of Physics: 8 units
- PHYS 050 and PHYS 051- General Physics

### Requirements of the Major

**Core (Required) Courses**: 30-32 units
- GEOL 001 - General Geology  
- GEOL 007 - Earth, Time and Life  
- GEOL 028 - Geology Outdoors  
- GEOL 100W - Writing Workshop (or equivalent)  
- GEOL 120 - Fundamentals of Mineralogy  
- GEOL 122 - Petrology  
- GEOL 124 - Sedimentology and Stratigraphy  
- GEOL 125 - Structural Geology  
- GEOL 129A - Introductory Field Geology  
- GEOL 129B - Advanced Field Geology

OR
- GEOL 129C - Intermediate Field Geology

Elective Courses - Complete 20 - 22 units from the following:  
- GEOL 127 - Tectonics  
- GEOL 130 - Marine Geology  
- GEOL 134 - Geomorphology  
- GEOL 135 - Geochemistry  
- GEOL 137 - Introduction to GPS/GIS for Geologic Applications  
- GEOL 138 - Hydrogeology  
- GEOL 140 - Principles of Engineering Geology  
- GEOL 142 - Paleontology
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 143</td>
<td>Active Tectonics</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 147</td>
<td>Introduction to Applied Geophysics</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 174</td>
<td>Hazardous Materials</td>
<td>3</td>
</tr>
<tr>
<td>MS 141</td>
<td>Geological Oceanography</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 180</td>
<td>Individual Studies (Can take twice)</td>
<td>1-2</td>
</tr>
</tbody>
</table>

**University Electives**

9

**Recommended**

- MATH 031 - Calculus II (Recommended for graduate school and technical careers)
### Major: BS Geology

#### Concentration in:

Total Units to Degree: 120

Academic Year: 2017 - 2018

The following road map is an advising tool that outlines a path of courses a student can take to complete requirements for graduation. This roadmap should be used in consultation with the catalog and your department to identify additional requirements for completing the major (for example course grade minimums). Students must have 60+ units in order to take SJSU Studies courses.

#### Fall Semester - Year 1

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE Area A1</td>
<td>3</td>
</tr>
<tr>
<td>GE Area A2 (ENGL 1A preferred)</td>
<td>3</td>
</tr>
<tr>
<td>GE Area E</td>
<td>3</td>
</tr>
<tr>
<td>Geology 1 (GE B1:B3)</td>
<td>4</td>
</tr>
<tr>
<td>University Elective</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Semester Units: 16

#### Spring Semester - Year 1

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE Area C2 (ENGL 1B preferred)</td>
<td>3</td>
</tr>
<tr>
<td>GE Area D1</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry 1A (GE B1:B3)</td>
<td>5</td>
</tr>
<tr>
<td>Geology 7 (GE B1 B3)</td>
<td>4</td>
</tr>
<tr>
<td>Geology 28</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Units: 16

#### Fall Semester - Year 2

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE Area D2 or D3/US123</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry 1B (GE B1:B3)</td>
<td>5</td>
</tr>
<tr>
<td>Geology 120</td>
<td>3</td>
</tr>
<tr>
<td>University Elective</td>
<td>3</td>
</tr>
<tr>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td>Register to take WST</td>
<td></td>
</tr>
</tbody>
</table>

Total Semester Units: 15

#### Spring Semester - Year 2

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE Area D2 or D3/US123</td>
<td>3</td>
</tr>
<tr>
<td>GE Area C1</td>
<td>3</td>
</tr>
<tr>
<td>GE Area C1 or C2</td>
<td>3</td>
</tr>
<tr>
<td>Math 30 (GE B4)</td>
<td>3</td>
</tr>
<tr>
<td>Geology 122</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Semester Units: 16

#### Fall Semester - Year 3

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 2A (GE B1:B3)</td>
<td>4</td>
</tr>
<tr>
<td>Geology 100W (Z)</td>
<td>3</td>
</tr>
<tr>
<td>Geology 124 (Area R)</td>
<td>3</td>
</tr>
<tr>
<td>Geology elective</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Semester Units: 14

#### Spring Semester - Year 3

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology 125</td>
<td>4</td>
</tr>
<tr>
<td>Geology elective</td>
<td>4</td>
</tr>
<tr>
<td>Physics 2B (GE B1:B3)</td>
<td>4</td>
</tr>
<tr>
<td>Geology 129A</td>
<td>2</td>
</tr>
<tr>
<td>PE</td>
<td>1</td>
</tr>
</tbody>
</table>

Total Semester Units: 15

#### Fall Semester - Year 4

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSU Studies (V)</td>
<td>3</td>
</tr>
<tr>
<td>Geology 129B</td>
<td>4</td>
</tr>
<tr>
<td>University Elective</td>
<td>3</td>
</tr>
<tr>
<td>Geology elective</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Semester Units: 14

#### Spring Semester - Year 4

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSU Studies (S)</td>
<td>3</td>
</tr>
<tr>
<td>University Elective</td>
<td>3</td>
</tr>
<tr>
<td>Geology elective</td>
<td>4</td>
</tr>
<tr>
<td>Geology elective</td>
<td>4</td>
</tr>
</tbody>
</table>

Total Semester Units: 14

NOTES: BS Geology majors are exempt from GE Area A3 and Area B2.
# B.A. EARTH SCIENCE REQUIREMENTS

<table>
<thead>
<tr>
<th>University Course Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Education Requirements</strong> - Includes &quot;Core GE&quot; (lower division) and &quot;SJSU Studies&quot; (upper division)</td>
<td>51</td>
</tr>
<tr>
<td>Core GE</td>
<td>39</td>
</tr>
<tr>
<td>SJSU Studies</td>
<td>12</td>
</tr>
</tbody>
</table>

*Of the 51 units required by the university, 15 may be satisfied by specified major and support requirements. Consult undergraduate advisor for details.*

See [info.sjsu.edu](http://info.sjsu.edu) for a listing of General Education courses.

| American Institutions                          | 6     |

*Of the 6 units required by the university, all may be satisfied within general education requirements as specified in the schedule of classes.*

See [info.sjsu.edu](http://info.sjsu.edu) for a listing of American Institutions courses.

| Physical Education                             | 2     |

See [info.sjsu.edu](http://info.sjsu.edu) for a listing of Physical Education courses.

<table>
<thead>
<tr>
<th>Major-Specific Course Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preparation for the Major</strong></td>
<td>32</td>
</tr>
<tr>
<td>ASTR 101 and ASTR 102 - Modern Astronomy and Astronomy Lab</td>
<td>6</td>
</tr>
<tr>
<td>CHEM 001A and CHEM 001B- General Chemistry</td>
<td>10</td>
</tr>
<tr>
<td>MATH 019- Precalculus</td>
<td>5</td>
</tr>
</tbody>
</table>

Complete one of the following:

- METR 112- Global Climate Changes: 3 units
- METR 113- Atmospheric Pollution: 3 units
Complete one sequence:

- PHYS 002A and PHYS 002B- Fundamentals of Physics 8
- PHYS 050 and PHYS 051- General Physics

Requirements of the Major

**Core Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 003</td>
<td>Planet Earth</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 004L</td>
<td>Planet Earth Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>GEOL 007</td>
<td>Earth, Time and Life</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 028</td>
<td>Geology Outdoors</td>
<td>1</td>
</tr>
<tr>
<td>GEOL 100W</td>
<td>Writing Workshop (or equivalent)</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 105</td>
<td>General Oceanography</td>
<td>3</td>
</tr>
</tbody>
</table>

**Geology Electives**- Complete 3 courses from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 120</td>
<td>Fundamentals of Mineralogy</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 122</td>
<td>Petrology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 124</td>
<td>Sedimentology and Stratigraphy</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 125</td>
<td>Structural Geology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 134</td>
<td>Geomorphology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 137</td>
<td>Introduction to GPS/GIS for Geologic Applications</td>
<td>4</td>
</tr>
</tbody>
</table>

**University Electives**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Other university courses approved by the undergraduate advisor.</td>
<td></td>
</tr>
</tbody>
</table>

**Teaching Candidates should take:**

- CHEM 120S- Chemical Safety Seminar 1
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 020</td>
<td>Ecological Biology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 021</td>
<td>Human Biology</td>
<td>3</td>
</tr>
</tbody>
</table>
The following road map is an advising tool that outlines a path of courses a student can take to complete requirements for graduation. This roadmap should be used in consultation with the catalog and your department to identify additional requirements for completing the major (for example course grade minimums). Students must have 60+ units in order to take SJSU Studies courses.

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE Area A1</td>
<td>3</td>
</tr>
<tr>
<td>GE Area E</td>
<td>3</td>
</tr>
<tr>
<td>GE Area A2 (Engl 1A preferred)</td>
<td>3</td>
</tr>
<tr>
<td>Geology 3 (GE B1)</td>
<td>3</td>
</tr>
<tr>
<td>Geology 4L (GE B3)</td>
<td>1</td>
</tr>
<tr>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 19 (B4)</td>
<td>5</td>
</tr>
<tr>
<td>Physics 2A (GE B1:B3)</td>
<td>4</td>
</tr>
<tr>
<td>GE Area D2 or D3/US123</td>
<td>3</td>
</tr>
<tr>
<td>GE Area C2</td>
<td>3</td>
</tr>
<tr>
<td>Register to take WST</td>
<td></td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology 100W (Z)</td>
<td>3</td>
</tr>
<tr>
<td>Chemistry 1A (GE B1:B3)</td>
<td>5</td>
</tr>
<tr>
<td>Geology Elective</td>
<td>3</td>
</tr>
<tr>
<td>Geology 125 preferred geology elective</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSU Studies (S)*</td>
<td>3</td>
</tr>
<tr>
<td>Metr 112 or 113</td>
<td>3</td>
</tr>
<tr>
<td>Upper Division elective*</td>
<td>3</td>
</tr>
<tr>
<td>Upper Division elective</td>
<td>3</td>
</tr>
<tr>
<td>University elective</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology 7 (GE B1 B3)</td>
<td>4</td>
</tr>
<tr>
<td>Geology 2B</td>
<td>1</td>
</tr>
<tr>
<td>GE Area A3</td>
<td>3</td>
</tr>
<tr>
<td>GE Area D1</td>
<td>3</td>
</tr>
<tr>
<td>GE Area C1</td>
<td>3</td>
</tr>
<tr>
<td>PE</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics 2B (GE B1:B3)</td>
<td>4</td>
</tr>
<tr>
<td>GE Area C1 or C2</td>
<td>3</td>
</tr>
<tr>
<td>GE Area D2 or D3/US123</td>
<td>3</td>
</tr>
<tr>
<td>University elective</td>
<td>3</td>
</tr>
<tr>
<td>University elective</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astr 101 (Area R)</td>
<td>3</td>
</tr>
<tr>
<td>Astr 102 (GE B3)</td>
<td>1</td>
</tr>
<tr>
<td>Chemistry 1B (GE B1:B3)</td>
<td>5</td>
</tr>
<tr>
<td>Geology 105</td>
<td>3</td>
</tr>
<tr>
<td>University elective</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course or Requirement</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSU Studies (V)*</td>
<td>3</td>
</tr>
<tr>
<td>Geology elective</td>
<td>3</td>
</tr>
<tr>
<td>Upper Division elective</td>
<td>3</td>
</tr>
<tr>
<td>Upper Division elective</td>
<td>3</td>
</tr>
<tr>
<td>University elective</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Semester Units:</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

NOTES: *Geology 168A and 168B (total 9 units) are preferred Area S and V courses and also count as 3 Upper Division electives. BA Earth Science majors are exempt from GE Area B2.
Degree Roadmap for Students who Completed the Transfer AS-T Degree in Geology

SJSU Degree: BS in Geology

The AS-T in Geology guarantees completion of 60 transferable units and all lower division core GE satisfied. This transfer degree will meet the CHEM 1A+1B, GEOL 1, 4L, 7, MATH 30, 31 requirements at SJSU. Below is the path to the BS Geology degree in 60 semester units with the transfer AS-T Geology degree:

<table>
<thead>
<tr>
<th>1st Semester at SJSU</th>
<th>Recommended Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>WST taken and passed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Prep – PHYS 2A or PHYS 50</td>
<td>PHYS 2A or PHYS 50</td>
<td>4</td>
</tr>
<tr>
<td>Major Core</td>
<td>GEOL 120</td>
<td>3*</td>
</tr>
<tr>
<td>Major Core</td>
<td>GEOL 100W</td>
<td>3*</td>
</tr>
<tr>
<td>Major Core and meets SJSU Studies Area R – GEOL 124</td>
<td>GEOL 124 (meets SJSU Studies Area R)</td>
<td>3*</td>
</tr>
<tr>
<td>P.E.</td>
<td>2 units of PE</td>
<td>2</td>
</tr>
<tr>
<td>Semester Total</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2nd Semester at SJSU</th>
<th>Recommended Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major 100W course, also satisfies SJSU Studies Area Z</td>
<td>GEOL 122</td>
<td>4*</td>
</tr>
<tr>
<td>Major Core</td>
<td>GEOL 125</td>
<td>4*</td>
</tr>
<tr>
<td>Major Core</td>
<td>GEOL 129A</td>
<td>2*</td>
</tr>
<tr>
<td>Major Prep – PHYS 2B or PHYS 51 (to follow physics course taken 1st sem at SJSU)</td>
<td>PHYS 2B or PHYS 51</td>
<td>4</td>
</tr>
<tr>
<td>Major Core</td>
<td>GEOL 28</td>
<td>1</td>
</tr>
<tr>
<td>Semester Total</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3rd Semester at SJSU</th>
<th>Recommended Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSU Studies Area S in US History (or a different Area S if US1 is met prior to transfer)</td>
<td>HIST 170S meets US1 + Area S (if US1 was met previously then take a different Area S course)</td>
<td>3*</td>
</tr>
<tr>
<td>Major Core – select 1 course from: GEOL 129B or GEOL 129C</td>
<td>GEOL 129B or GEOL 129C</td>
<td>2*</td>
</tr>
<tr>
<td>Major Geology Electives – select 10 units from: GEOL 127, 130, 134, 135, 136, 137,138, 140, 142, 143, 147, 174, or MS 141</td>
<td>GEOL 127, 130, 134, 135, 136, 137,138, 140, 142, 143, 147, 174, or MS 141</td>
<td>10*</td>
</tr>
<tr>
<td>Semester Total</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4th Semester at SJSU</th>
<th>Recommended Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>SJSU Studies Area V in US Government &amp; California (or a different Area V if US2+3 is met prior to transfer)</td>
<td>POLS 170V meets US2+3 + Area V (if US2+3 was met previously then take a different Area V course)</td>
<td>3*</td>
</tr>
<tr>
<td>Major Geology Electives – select 12 units from: GEOL 127, 130, 134, 135, 136, 137,138, 140, 142, 143, 147, 174, or MS 141</td>
<td>GEOL 127, 130, 134, 135, 136, 137,138, 140, 142, 143, 147, 174, or MS 141</td>
<td>12*</td>
</tr>
<tr>
<td>Semester Total</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

*Notes: A minimum of 40 upper division units must be completed for degree. This roadmap is a sample pathway. Check with a major advisor regarding the most appropriate course sequence for you. 60 units minimum will be transferred with this degree, however up to 70 transfer units can be applied to the lower division and lower division free electives if articulated.
# MINOR IN GEOLOGY -- REQUIREMENTS

<table>
<thead>
<tr>
<th>Minor-Specific Course Requirements</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Courses</strong></td>
<td>9</td>
</tr>
<tr>
<td>• GEOL 001- General Geology</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 007- Earth, Time and Life</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 028- Geology Outdoors</td>
<td>1</td>
</tr>
<tr>
<td><strong>Geology Electives</strong></td>
<td>6</td>
</tr>
<tr>
<td>Complete six units. At least one</td>
<td></td>
</tr>
<tr>
<td>upper division course must include</td>
<td></td>
</tr>
<tr>
<td>a lab.</td>
<td></td>
</tr>
<tr>
<td>• GEOL 105- General Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>• GEOL 107- Prehistoric Life</td>
<td>3</td>
</tr>
<tr>
<td>• GEOL 111- Geology and the Environment</td>
<td>3</td>
</tr>
<tr>
<td>• GEOL 112- Hazards, Risks of Earthquakes and Volcanoes</td>
<td>3</td>
</tr>
<tr>
<td>• GEOL 120- Fundamentals of Mineralogy (+ lab)</td>
<td>3</td>
</tr>
<tr>
<td>• GEOL 122- Petrology (+ lab)</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 124- Sedimentology and Stratigraphy (+ lab)</td>
<td>3</td>
</tr>
<tr>
<td>• GEOL 125- Structural Geology (+ lab)</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 134- Geomorphology (+ lab)</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 135- Geochemistry (+ lab)</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 137- Introduction to GPS/GIS for Geologic Applications (+ lab)</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 138- Hydrogeology (+ lab)</td>
<td>4</td>
</tr>
<tr>
<td>• GEOL 142- Paleontology (+ lab)</td>
<td>4</td>
</tr>
</tbody>
</table>
## APPENDIX 9.4. RUBRICS

### Rubric for Quantitative and Scientific Reasoning

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Calculations</th>
<th>Visual Representation of Data &amp; Information</th>
<th>Scientific Methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4 (Advanced)</strong></td>
<td>- Demonstrates advanced reasoning based on quantifiable information; judgements and conclusions are exceptionally insightful</td>
<td>- Accurately completes all calculations for the assignments and presents results clearly and concisely</td>
<td>- Produces highly effective visual representations of data (e.g. tables) or concepts (e.g. graphs)</td>
</tr>
<tr>
<td></td>
<td>- Produces an analysis of data</td>
<td>- Produces work that contributes to the field</td>
<td>1. Identify problem</td>
</tr>
<tr>
<td></td>
<td>- Produces work that meets the requirements of the assignments/course</td>
<td>- Produces competent visual representations of data</td>
<td>2. Formulate a hypothesis</td>
</tr>
<tr>
<td></td>
<td>- Produces an analysis of data</td>
<td>- Produces work that contributes to the field</td>
<td>3. Design a project to test hypothesis</td>
</tr>
<tr>
<td></td>
<td>- Produces work that meets the requirements of the assignments/course</td>
<td>- Produces work that contributes to the field</td>
<td>4. Collect data</td>
</tr>
<tr>
<td></td>
<td>- Produces an analysis of data</td>
<td>- Produces work that contributes to the field</td>
<td>5. Analyze data</td>
</tr>
<tr>
<td></td>
<td>- Produces work that meets the requirements of the assignments/course</td>
<td>- Produces work that contributes to the field</td>
<td>6. Draw conclusions based on data</td>
</tr>
<tr>
<td></td>
<td>- Produces an analysis of data</td>
<td>- Produces work that meets the requirements of the assignments/course</td>
<td>- Exhibits a highly accurate and exhaustive analysis of data</td>
</tr>
<tr>
<td><strong>3 (Competent)</strong></td>
<td>- Demonstrates competent reasoning based on quantifiable information; judgements and conclusions are adequate and reasonable</td>
<td>- Calculations are completed and largely successful</td>
<td>- Engages in all 6 steps needed in undertaking a science-based approach to gathering and interpreting evidence</td>
</tr>
<tr>
<td></td>
<td>- Chooses appropriate formulas or symbolic models to solve problems and justify choices</td>
<td>- Produces competent visual representations of data</td>
<td>- Produces an analysis of data</td>
</tr>
<tr>
<td></td>
<td>- Produces work that meets the requirements of the assignments/course</td>
<td>- Produces work that meets the requirements of the assignments/course</td>
<td>- Produces work that meets the requirements of the assignments/course</td>
</tr>
<tr>
<td><strong>2 (Emerging)</strong></td>
<td>- Demonstrates emerging reasoning based on quantifiable information as exhibited by difficulty in formulating judgements or drawing conclusions</td>
<td>- Calculations contain multiple errors</td>
<td>- Engages in the 6 steps but may exhibit problems with a few parameters</td>
</tr>
<tr>
<td></td>
<td>- May not choose the most appropriate or effective formula</td>
<td>- May exhibit some problems justifying choices</td>
<td>- Analysis of data may reflect minor inaccuracies of observation</td>
</tr>
<tr>
<td></td>
<td>- Visual representations may reflect minor flaws or inaccuracies</td>
<td>- Visual representations may reflect minor flaws or inaccuracies</td>
<td>- Work may not fully satisfy the requirements of the assignment/course</td>
</tr>
<tr>
<td></td>
<td>- May exhibit some problems justifying choices</td>
<td>- Visual representations may reflect minor flaws or inaccuracies</td>
<td>- Work may not fully satisfy the requirements of the assignment/course</td>
</tr>
<tr>
<td><strong>1 (Beginning)</strong></td>
<td>- Demonstrates beginning reasoning based on quantifiable information as exhibited by difficulty understanding what constitutes quantifiable information, inability to formulate reasonable conclusions</td>
<td>- Calculations may be unsuccessful or incomplete</td>
<td>- Exhibits problems in many if not most of the steps required for the scientific process</td>
</tr>
<tr>
<td></td>
<td>- Does not appear to understand the parameters of the appropriate formula</td>
<td>- Exhibits problems in many if not most of the steps required for the scientific process</td>
<td>- Analysis of data is incomplete, inaccurate, or absent</td>
</tr>
<tr>
<td></td>
<td>- Is unable to select the right formula for the problem (decision-making unclear)</td>
<td>- Exhibits problems in many if not most of the steps required for the scientific process</td>
<td>- Work does not satisfy the requirements of the assignment/course</td>
</tr>
</tbody>
</table>
### Quantitative Literacy Value Rubric

<table>
<thead>
<tr>
<th>Interpretation</th>
<th>Capstone 4</th>
<th>Milestones 3</th>
<th>Benchmark 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to explain information presented in mathematical forms (e.g., equations, graphs, diagrams, tables, words)</td>
<td>Provides accurate explanations of information presented in mathematical forms. Makes appropriate inferences based on that information. For example, accurately explains the trend data shown in a graph and makes reasonable predictions regarding what the data suggest about future events.</td>
<td>Provides somewhat accurate explanations of information presented in the mathematical forms, but occasionally misinterprets or misapplies the information. For example, accurately explains the trend data shown in a graph, but will frequently misinterpret the nature of that trend, perhaps by confusing positive and negative trends.</td>
<td>Attempts to explain information presented in the mathematical forms, but draws incorrect conclusions about what the information means. For example, attempts to explain the trend data shown in a graph, but will frequently misinterpret the nature of that trend, perhaps by confusing positive and negative trends.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Representation</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to convert relevant information into various mathematical forms (e.g., equations, graphs, diagrams, tables, words)</td>
<td>Skillfully converts relevant information into an insightful mathematical portrayal in a way that contributes to a fuller or deeper understanding.</td>
<td>Competently converts relevant information into an appropriate and desired mathematical portrayal.</td>
<td>Complete conversion of information but resulting mathematical portrayal is only partially appropriate or accurate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculation</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem. Calculations are also presented elegantly (clearly, concisely, etc.)</td>
<td>Calculations attempted are essentially all successful and sufficiently comprehensive to solve the problem.</td>
<td>Calculations attempted are either unsuccessful or represent only a portion of the calculations required to comprehensively solve the problem.</td>
<td>Calculations are attempted but both are unsuccessful and are not comprehensive.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application/Analysis</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to make judgements and draw appropriate conclusions based on the quantitative analysis of data, while recognizing the limits of this analysis</td>
<td>Uses the quantitative analysis of data as the basis for deep and thoughtful judgements, drawing insightful, carefully qualified conclusions from this work.</td>
<td>Uses the quantitative analysis of data as the basis for competent judgements, drawing reasonable and appropriately qualified conclusions from this work.</td>
<td>Uses the quantitative analysis of data as the basis for tentative, basic judgements, although is hesitant or uncertain about drawing conclusions from this work.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumptions</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability to make and evaluate important assumptions in estimation, modeling, and data analysis</td>
<td>Explicitly describes assumptions and provides compelling rationale for why each assumption is appropriate. Shows awareness that confidence in final conclusions is limited by the accuracy for the assumptions.</td>
<td>Explicitly describes assumptions and provides compelling rationale for why assumptions are appropriate.</td>
<td>Attempts to describe assumptions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communicator</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses qualitative information in connection with the</td>
<td>Uses quantitative information in connection with the</td>
<td>Uses quantitative information in connection with the</td>
<td>Presents an argument for which quantitative evidence</td>
</tr>
<tr>
<td>Writing Outcome</td>
<td>Below Basic</td>
<td>Developing</td>
<td>Proficient</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>Focus</td>
<td>Thesis is unidentifiable or does not fit the writing assignment.</td>
<td>Thesis fits the writing assignment.</td>
<td>Thesis fits the writing assignment, typically explains concepts coherently.</td>
</tr>
<tr>
<td>Analysis and Organization</td>
<td>Ideas not explained; inadequate or inconsistent</td>
<td>Typically explains concepts, overdevelops concepts coherently</td>
<td>Develops concepts coherently</td>
</tr>
<tr>
<td>Readability and Style</td>
<td>Spelling, syntax, diction, or</td>
<td>Spelling, syntax, diction, or</td>
<td>Spelling, syntax, diction, or</td>
</tr>
</tbody>
</table>

**Student Writing Development**
## Final Presentation Rubric

<table>
<thead>
<tr>
<th>Component</th>
<th>Sophisticated</th>
<th>Competent</th>
<th>Not Yet Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content and</td>
<td>The presentation contained an</td>
<td>The presentation contained</td>
<td>The audience had to make</td>
</tr>
<tr>
<td>Coherence and</td>
<td>The thesis, argument and solution</td>
<td>The thesis, arguments and solution</td>
<td>The thesis, argument, solution and</td>
</tr>
<tr>
<td>Speaking Skills</td>
<td>Team members were poised and</td>
<td>Team members were mostly</td>
<td>Team members were often</td>
</tr>
</tbody>
</table>

## Individual Reflection Rubric

<table>
<thead>
<tr>
<th>Component</th>
<th>Sophisticated</th>
<th>Competent</th>
<th>Not Yet Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributions</td>
<td>The individual contributed in a</td>
<td>The individual did not contribute as</td>
<td>The individual did not contribute to</td>
</tr>
<tr>
<td>Lessons</td>
<td>The individual had a level of</td>
<td>The individual had a level of</td>
<td>The individual had a level of</td>
</tr>
</tbody>
</table>
The grade assigned for the Schell Creek report is based on the breakdown below. Comments are also included to supplement the comments that I made on the actual material that you turned in to me (report, maps, and cross sections).

<table>
<thead>
<tr>
<th>Grading criteria and point values</th>
<th>Comments</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Completeness</strong>—all parts of report are present as specified in syllabus.</td>
<td>5 points.</td>
<td></td>
</tr>
<tr>
<td><strong>Writing</strong>—clear and concise exposition, logical discussion, appropriate use of geologic terms (bearing in mind the limited time and field conditions)</td>
<td>10 points.</td>
<td></td>
</tr>
<tr>
<td><strong>Map</strong>—stratigraphic contacts and faults clearly labeled, legend is complete and corresponds to map, adequate number of attitudes, map makes reasonable geologic sense.</td>
<td>25 points.</td>
<td></td>
</tr>
<tr>
<td><strong>Cross-sections</strong>—Well-constrained by map relations, chosen to show most important structural and stratigraphic relationships, well-labeled, fault dips and bed dips are accurate based on line of section (apparent versus true dip where necessary)</td>
<td>25 points.</td>
<td></td>
</tr>
<tr>
<td>Criteria</td>
<td>Comments</td>
<td>Score</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Rock Descriptions--hand sample, bedding, and outcrop characteristics, sed. structures (if relevant), thickness estimates, contact relations. <strong>20 points</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure--relation of beds to faults, stratal tilts across faults, dips of faults, fault geometry (e.g. planar, listric), folding (if present), displacement directions, fault ages and sequence of faulting where applicable (e.g. high angle cutting low angle?), stereonets, discussion well-integrated with mapping. <strong>30 points</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geomorphology--discussion of landform evolution (e.g. tectonic vs. erosion controls), climate and rock type, differential weather-ing. <strong>10 points</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geologic History--Complete geologic evolution of area based on rock types (e.g. depositional environments, volcanism) and faulting history. Appropriate background and overview. Adequately incorporates work from others in camp and outside references. <strong>25 points</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Comments and Intangibles
The grade assigned for the Snake Range report is based on the breakdown below. Comments are also included to supplement the comments that I made on the actual material that you turned in to me (report, maps, and cross sections).

<table>
<thead>
<tr>
<th>Grading criteria and point values</th>
<th>Comments</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Writing</strong> -- clear and concise exposition, logical discussion, appropriate use of geologic terms (bearing in mind the limited time in the field).</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td><strong>Map</strong> -- stratigraphic contacts and SRD clearly labeled, legend is complete and corresponds to map, representative attitudes.</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td><strong>Structure</strong> -- Sufficient number of structural data (foliations, lineations, fold hingelines, joints) for discussion of footwall deformation. Data plotted neatly on stereonets, discussion of structural data well-integrated with map relations, and stereonet plots.</td>
<td>25 points</td>
<td></td>
</tr>
<tr>
<td><strong>Metamorphism</strong> -- Brief but logical discussion of staurolite and garnet isograds</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td><strong>Geologic History</strong> -- Brief discussion of SRD (can be integrated with structure discussion)</td>
<td>10 points</td>
<td></td>
</tr>
</tbody>
</table>
Additional Comments and Intangibles
<table>
<thead>
<tr>
<th>Graduation Year</th>
<th>Degree(s) at SJSU.</th>
<th>Field(s) employed in</th>
<th>&quot;other geology&quot; or &quot;other non-geology&quot;.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>M.S.</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>B.S.</td>
<td>Other non-geology</td>
<td>geotechnical engineer &amp; engineering geology</td>
</tr>
<tr>
<td>1980 and 1987</td>
<td>B.S., M.S.</td>
<td>Environmental consulting</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>B.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>B.S.</td>
<td>Other geology</td>
<td>Principle Seismologist, PG&amp;E</td>
</tr>
<tr>
<td>1999</td>
<td>M.S.</td>
<td>Environmental consulting</td>
<td></td>
</tr>
<tr>
<td>~1982(?)</td>
<td>B.A</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>M.S.</td>
<td>Engineering Geology consulting</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>B.S.</td>
<td>Environmental consulting</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>B.S.</td>
<td>Other geology</td>
<td>I do asbestos testing.</td>
</tr>
<tr>
<td>1971</td>
<td>B.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>M.S.</td>
<td>Environmental consulting</td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>B.A</td>
<td>Other geology</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>B.S.</td>
<td>Mining</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>B.S.</td>
<td>Other non-geology</td>
<td>Clinical Operations, Biopharma</td>
</tr>
<tr>
<td>1979</td>
<td>M.S.</td>
<td>Petroleum</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>M.S.</td>
<td>Other geology</td>
<td>Geomorphology</td>
</tr>
<tr>
<td>2012</td>
<td>B.S.</td>
<td>Mining</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>B.A</td>
<td>Petroleum</td>
<td>Environmental, health &amp; Safety consulting</td>
</tr>
<tr>
<td>1991</td>
<td>M.S.</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>M.S.</td>
<td>Engineering Geology consulting</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>B.S.</td>
<td>Mining</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>B.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>B.S., M.S.</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Degree</td>
<td>Field</td>
<td>Current Position/Industry</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>-------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>1973</td>
<td>B.A, M.S.</td>
<td>Other non-geology</td>
<td>Geoarchaeology</td>
</tr>
<tr>
<td>1973</td>
<td>M.S.</td>
<td>Other non-geology</td>
<td>Engineering Geology consulting</td>
</tr>
<tr>
<td>1983</td>
<td>M.S.</td>
<td>Engineering Geology consulting</td>
<td>Government</td>
</tr>
<tr>
<td>1976</td>
<td>B.S., M.S.</td>
<td>Other non-geology</td>
<td>Government</td>
</tr>
<tr>
<td>1977</td>
<td>M.S.</td>
<td>Petroleum</td>
<td>Government</td>
</tr>
<tr>
<td>1979</td>
<td>M.Sc</td>
<td>Petroleum</td>
<td>Government</td>
</tr>
<tr>
<td>1983</td>
<td>M.S.</td>
<td>Other non-geology</td>
<td>Editor and writer</td>
</tr>
<tr>
<td>1985</td>
<td>M.S.</td>
<td>Petroleum</td>
<td>Government</td>
</tr>
<tr>
<td>1986</td>
<td>B.S.</td>
<td>Other non-geology</td>
<td>Law Enforcement (retired)</td>
</tr>
<tr>
<td>1988</td>
<td>B.S., M.S.</td>
<td>Other geology</td>
<td>geothermal for electric power industry</td>
</tr>
<tr>
<td>1995</td>
<td>B.S.</td>
<td>Other geology</td>
<td>planetary geosciences</td>
</tr>
<tr>
<td>1998</td>
<td>B.S.</td>
<td>Environmental consulting</td>
<td>Sales</td>
</tr>
<tr>
<td>2000</td>
<td>M.S.</td>
<td>University/college education</td>
<td>Mining</td>
</tr>
<tr>
<td>2001</td>
<td>B.S.</td>
<td>Engineering Geology consulting</td>
<td>Environmental Laboratory</td>
</tr>
<tr>
<td>2004</td>
<td>B.S.</td>
<td>Environmental consulting</td>
<td>Government</td>
</tr>
<tr>
<td>2008</td>
<td>M.S.</td>
<td>University/college education</td>
<td>Government</td>
</tr>
<tr>
<td>2012</td>
<td>B.S.</td>
<td>Other non-geology</td>
<td>Art and Framing</td>
</tr>
<tr>
<td>2013</td>
<td>B.S.</td>
<td>Environmental consulting</td>
<td>Sales</td>
</tr>
<tr>
<td>2014</td>
<td>B.S.</td>
<td>Engineering Geology consulting</td>
<td>Developmental Chemist for PCR Diagnostics</td>
</tr>
<tr>
<td>2014</td>
<td>M.S.</td>
<td>University/college education</td>
<td>Environment Laboratory</td>
</tr>
<tr>
<td>2015</td>
<td>B.S.</td>
<td>Environmental consulting</td>
<td>Government</td>
</tr>
<tr>
<td>2020</td>
<td>B.S.</td>
<td>Environmental consulting</td>
<td>Government</td>
</tr>
<tr>
<td>Year</td>
<td>Degree</td>
<td>Major</td>
<td>Employment Details</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>2014</td>
<td>M.S.</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>M.S.</td>
<td>Other non-geology</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>M.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>B.S.</td>
<td>Engineering Geology consulting</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>B.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>M.S.</td>
<td>Other non-geology</td>
<td>Environmental planner for a university</td>
</tr>
<tr>
<td>2016</td>
<td>B.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>B.A</td>
<td>Government</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>B.S., M.S.</td>
<td>Petroleum</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>M.S.</td>
<td>Government</td>
<td>Liquefaction hazards, now retired.</td>
</tr>
<tr>
<td>2014</td>
<td>M.S.</td>
<td>Engineering Geology consulting</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>M.S.</td>
<td>Environmental consulting</td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td>M.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>2008; 2017</td>
<td>B.S., M.S.</td>
<td>University/college education</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>B.A, M.S.</td>
<td>Other non-geology</td>
<td>USGS, then materials analyst for semiconductors</td>
</tr>
<tr>
<td>2015</td>
<td>M.S.</td>
<td>Environmental consulting</td>
<td></td>
</tr>
<tr>
<td>1982</td>
<td>B.A</td>
<td>Other non-geology</td>
<td>I work as a multi-media technician</td>
</tr>
<tr>
<td>1991</td>
<td>B.S.</td>
<td>Other non-geology</td>
<td>Information Technology Project Management</td>
</tr>
<tr>
<td>1965</td>
<td>B.A</td>
<td>Other non-geology</td>
<td>Soil Scientist</td>
</tr>
<tr>
<td>1976</td>
<td>B.S.</td>
<td>Petroleum</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>B.S.</td>
<td>Other non-geology</td>
<td>Information Technology</td>
</tr>
</tbody>
</table>
APPENDIX 9.6

Program Review
Department of Geology
San José State University
Spring 2012

Prepared by June Oberdorfer
With contributions from all other faculty members and from staff members

Departmental faculty and staff
David Andersen sedimentary geology, stratigraphy, tectonics
Emmanuel Gabet geomorphology, engineering geology
Jonathan Hendricks paleontology, historical geology
Paula Messina GIS/GPS, teacher training, tectonics
Ellen Metzger mineralogy, metamorphic petrology, tectonics, teacher training
Jonathan Miller igneous petrology, field geology, tectonics
Robert Miller structural geology, field geology, tectonics, department chair
June Oberdorfer hydrogeology, environmental geology
Donald Reed marine geophysics, tectonics, computer-based geology
Richard Sedlock structural geology, field geology, tectonics, teacher training

Leslie Blum administrative staff
Alphonse Odisho technical staff
Virginia Smith technical staff
# Table of Contents

Part 1: Program Strengths ............................................................................................................... 1
    1.1 Ability to Modify Curriculum and Degree Programs ........................................................... 1
    1.2 Strong Tradition of Self Assessment .................................................................................... 1
    1.3 Excellent Reputation in COS, SJSU, CSU, and Beyond – Evidence From Faculty Activity Since the Last Review ................................................................................................................. 2
    1.4 Long-standing support of GE and Science Education needs ................................................ 3

Part 2: Program Challenges ............................................................................................................ 4
    2.1 Equipment ............................................................................................................................. 4
    2.2 Faculty Recruitment .............................................................................................................. 4
    2.3 Space Needs .......................................................................................................................... 5
    2.4 Overworked Support Staff .................................................................................................... 5

Part 3: Program Synergies .............................................................................................................. 6
    3.1 Possible interdisciplinary program in Sustainability/Climate Change ................................. 6
    3.2 Connections Across Campus ................................................................................................ 6
    3.3 Increasing Existing Ties ........................................................................................................ 6
    3.4 Science Education ................................................................................................................. 7
    3.5 Interactions with the Community .......................................................................................... 7
    3.6 Interactions with other Universities/Colleges ....................................................................... 7

Part 4: WASC Program Outcome Rubric ....................................................................................... 8
    4.1 Comprehensive List .............................................................................................................. 8
    4.2 Assessable Outcomes ............................................................................................................ 8
    4.3 Alignment ............................................................................................................................. 9
    4.4 Assessment Planning ............................................................................................................ 9
    4.5 The Student Experience ...................................................................................................... 10

Part 5: Student Learning in Program ............................................................................................ 11
    5.1 Evaluation of Student Learning for SLOs .......................................................................... 11
    5.2 Development of Rubrics for Program Level Outcomes ..................................................... 12
    5.3 Evaluation of Internal Assessment Process of Student Learning ....................................... 12
    5.4 Effectiveness and Currency of Pedagogy ........................................................................... 12
    5.5 Cultivating Global Citizens ................................................................................................. 13
    5.6 Developing Skills of a Global Citizen ................................................................................ 13
    5.7 Action Items Developed from Evaluation .......................................................................... 13

Part 6: Required Data Elements .................................................................................................... 14
    6.1 Problem Areas ..................................................................................................................... 14
    6.2 Progress towards University or College Strategic Plan Goals ............................................ 16

Part 7: Summary ........................................................................................................................... 16

Appendix A: Required Data Elements
Appendix B: GE Recertification
Part 1: Program Strengths

The Department of Geology has many reasons to be proud of its program, including the breadth of its degree and course offerings, its research, its service to the community and the quality and accomplishments of its students.

1.1 Ability to Modify Curriculum and Degree Programs

The Department reviews its curricular and degree offerings on a regular basis and has had particularly intense discussion as part of the Program Review. Based on these discussions, revisions to the degree programs are being made at multiple levels:

- **Geology Minor**: increase the rigor to include at least one Upper Division major course, rather than permitting all requirements to be met by GE courses;
- **B.A. Earth Sciences**: increase rigor for the prospective teachers in this program by requiring earth materials and structural geology;
- **Introductory sequence for B.S. majors**: shift from Geol 3/4L/7 to Geol 1(1L)/7 to allow for a more in-depth examination of earth materials and earth history;
- **Content of Geol 3 and 4L**: revised to enhance the earth systems approach;
- **Earth Systems capstone course**: new course to be offered as an elective, as an alternative and/or compliment to the existing synthesis course in Tectonics; it provides an interdisciplinary, in-depth view of the “spheres” interacting on Earth; and
- **M.S. Writing Preparation**: require higher TOEFL scores for non-native speakers and a more-detailed, written Statement of Purpose in the application.

1.2 Strong Tradition of Self Assessment

In 2003, the Department comprehensively re-examined the content, goals, and articulation of all courses in the major. This led to many changes in individual courses, course sequencing, and degree programs. For the most part, these changes worked out well, with some subsequent modifications over time. An example of a modification was the increase of Geology 122 (Petrology) from a four-unit to five-unit course, which also included concepts from Geology 120 (Mineralogy). After teaching the course as a 5-unit course one time, it was determined that a refocused 4-unit version would better meet the needs of the students, and the course was changed back with Mineralogy restored as a separate course. Similarly, the current revision to require Geol 1 (with a required accompanying lab) instead of 3 and 4L revises a decision made in 2003, reflecting the current changes to the B.S. describe in Sec. 1.1. Over this same time frame, a number of the Geology electives have been increased from 3-unit to 4-unit courses because of the appreciable amount of work required of the students in these classes and the faculty’s recognition that it was difficult to cover the necessary material with only two hours of lecture plus a lab.

In addition to the modifications to the curriculum, the discussion in 2003 led to a formulation of Student Learning Objectives (SLOs) at both the undergraduate and graduate levels. These were described in our 2005 Program Review. The Department regularly evaluates
these SLOs, and then summarizes and reports the results. Modifications to the teaching methods or content and/or to the assessment approach are made as needed.

1.3 Excellent Reputation in COS, SJSU, CSU, and Beyond – Evidence From Faculty Activity Since the Last Review

The Faculty actively engages in a wide range of research, professional organization, and consulting activities. Since the last review in 2005, the Faculty has obtained funding for 38 grants for a total amount of $2,553,000. One grant is a joint collaboration with one of our part-time instructors. Funding agencies include the National Science Foundation, U.S. Geological Survey, NASA, Earth Systems Education Alliance, and the Netherlands Research Center for Integrated Solid Earth Sciences. Of these grants, six for a total of $306,482 were made through the Tower Foundation from entities such as Chevron, Intel, and the Heller Foundation.

The Faculty has published 70 refereed papers, as well as 5 non-refereed articles since the last review in 2005. In addition, there have been a number of articles published in circulars and online (e.g., internally-reviewed and on the U.S. Geological Survey website) that were closely peer-reviewed. A faculty member has edited a book on the geology of Barbados, and another member edited a book on the importance of crustal sections, both for the Geological Society of America. The Faculty gave 98 presentations with abstracts (many with their students) and 38 additional professional presentations without abstracts, both nationally and internationally. A number of individuals have also supported the department’s teacher-training activities by giving presentations, beyond the numerous (19) one-day events and seven one-week workshops given by the two faculty members primarily involved.

Department members have also chaired multiple sessions at professional meetings and acted as Chair and as Technical Chair at a regional meeting (Cordilleran Section of the Geological Society of America). They have served on multiple NSF panels and acted as peer reviewers on NSF proposals. Faculty have received external recognition (e.g., Honorary Membership in the Pacific Section of the Society for Sedimentary Geology, appointment as Research Associate of the Paleontological Research Institution in Ithaca, NY, recipient of “most cited article award” from Terrestrial, Atmospheric and Ocean Science Journal). They have acted as associate editor and on the editorial board of internationally-recognized journals (e.g., Tectonics, Geology). They have also served as peer reviewers for scientific journals such as Science, Geology, Geological Society of America Bulletin, Earth and Planetary Science Letters, Tectonics, Journal of Petrology, Journal of Geology, and Tectonophysics, among others. In addition, faculty members interact with consulting companies and regulatory agencies, bringing practical applications into the classroom as well as providing contacts for future student employment.

With respect to science education at the national level, faculty members have served on major committees (e.g., the College Board’s A.P. Science Redesign Writing Team, the College Board’s Science Academic Advisory Committee, and the Writing Team for the Next Generation Science Standards based on the National Academies’ Science Framework, Deep Earth Academy, Centers of Ocean Science Education Excellence Program, and NSF-MARGINS Education Advisory Committee).

These activities recognize the scientific excellence of the Faculty and offer the students research experiences at both the graduate and undergraduate level, provide examples/case studies for discussion in courses, and facilitate contacts for collaborations and future employment. The
Department is also proud of its long-term, part-time faculty who have given multiple oral presentations with abstracts, led teacher-training workshops, and participated heavily in interactions with the community, such as acting as science fair judges or science bowl moderators and presenting at career fairs. One part-time instructor is actively involved in projects to increase the participation of under-represented groups in the geosciences.

The high quality of the Masters theses produced by the Department is widely recognized across campus and beyond. In the last seven years, theses from the Department have won Best Thesis awards twice, and students from the Department have received this recognition seven other times, the most of any department in the University. In addition, one student won the SJSU Outstanding Student Research Award. An M.S. thesis from the Department was also recognized as Best Thesis by the Western Association of Graduate Schools, the only time that University has received that honor. The Graduate School has never rejected theses submitted by our students, and any required modifications to the theses are minor. Many of our students give presentations on their results at regional and national professional meetings (including winning best student poster at the Cordilleran Section [western U.S.] Geological Society of America Meeting), in addition to the required presentations to the Department during the weekly Geology Club talks. Additionally, undergraduates are being involved to a greater degree in research; two seniors completed Honors theses with faculty this academic year, and at least five undergraduates have given presentations at regional or national meetings during the review period.

Our students are well prepared to meet a wide variety of society needs as evidenced by the range of employers: local, state and federal government agencies, environmental, geologic, and geophysical consulting firms, petroleum companies, and teaching institutions (K-14 and universities). Their course activities include the preparation of consulting-style reports on topics such as groundwater or fault investigations similar to what would be sent to a regulatory agency. This type of undergraduate instruction prepares students both to write a comprehensive report and to integrate multiple aspects of a geologic study. Similarly, the field map and report prepared during the culminating summer-field experience prepares them well to synthesize complex geologic information from field studies.

The Department has had a number of international collaborations with universities in Australia, England, France, Italy, the Netherlands, Scotland, and Turkey. Faculty members have also participated in international research groups, such as United Nations Educational, Scientific, and Cultural Organization, International Atomic Energy Agency, and Institute of Earth Science (Taiwan). Research projects have been carried out in Australia, Brazil, Italy, Mauritius, Mexico, Oman, and Switzerland. Students have come to the Department from many countries, including Scotland, China, India, the Philippines, Japan, Taiwan, and Scotland. These interactions have enriched both the students’ and faculty members’ perspectives on global issues.

Lastly, the Department is known around campus as being organized and efficient, meeting deadlines effectively. This results, in part, from our being a very collegial department. When a task needs to be done, all members of the Department take their turns in contributing to what needs to get completed.

1.4 Long-standing support of GE and Science Education needs

The Department of Geology has long made significant contributions to the GE program (both Core GE in areas B1 and B3 and SJSU Studies in Area R). One unusual offering that meets the needs of many students and is very popular is the 1-unit, free-standing laboratory course (Geol 4L) that satisfies Area B3. Several of the GE courses (Geol 3, 105, 111, and 171)
offer completely online sections, meeting an increasing demand from busy or distant students. The online General Oceanography course (Geol 105) has won awards and accolades for the high quality of its content and methods.

The Department has two faculty members who work half-time in Science Education. The Department offers an Earth Science course (Geol 103) needed for the Elementary Credential. It also offers a graduate level course (Geol 204) entitled Earth Systems Science for Teachers. In addition, faculty in the Department have obtained grants to offer a number of teacher workshops (most through BAESI, the Bay Area Earth Science Institute, which is housed within the Department) both during the summer and the regular academic year to provide professional development for K-12 teachers in earth science.

Part 2: Program Challenges

2.1 Equipment

Both faculty and student research is hampered by the lack of major analytical equipment, which requires them to travel to other facilities to perform the analyses. Major analytical equipment needed by the Department includes a research-grade X-ray diffraction machine, a desktop X-ray fluorescence machine, and a table-top scanning electron microscope. One or two additional four-wheel drive vehicles are also needed for the field program to replace aging, current vehicles. Equipment used regularly in instruction as well as in research that needs upgrading or replacement includes microscopes, geophysics equipment, a rock crusher, pressure transducers/data loggers for water levels, and computers for the computer lab (not to mention Faculty offices). Additional items that would benefit instruction and research include seismic data processing software, updated groundwater modeling software, a flow-through water-quality cell with sensors, updates for Adobe and other out-of-date software, and built-in computer projectors in the classrooms.

2.2 Faculty Recruitment

Over the last review period, the Department has lost one position, being reduced from 11 to 10 tenured/tenure-track faculty. Two of these faculty members have split appointments with Science Education. Retirements effective in the 2012-2013 academic year will reduce the faculty by 1.5 positions (one member entering FERP) to 8.5 positions (7.5 FTEF). The Department anticipates the need to replace two to four other faculty members in the time period before the next Review. The Department has prioritized four critical areas of expertise.

- Neotectonics—An individual who can teach Structural Geology and participate in the Field Geology program, preferably with expertise in Engineering Geology, Seismic Hazard Analysis, or both. This is a first priority as a replacement for a faculty member who will retire without FERPing in summer 2012. We hope to conduct a search for this position in Fall 2012.
- Sedimentology—A replacement for a faculty member retiring May 2012. We hope to hire a replacement in the next few years.
• Low-temperature geochemistry—Preferably someone with expertise in paleoclimate and/or watershed hydrology, to expand into an area of growing demand in the Earth Sciences.
• Hydrogeology—A replacement for a faculty member retiring May 2016.

The exact sequence of searches will be a function of the timing of retirements and participation in the FERP program.

The Department has experienced difficulties in hiring in the recent past (paleoclimatology and/or paleontology position went through three sequential searches) due to the high cost of living in the San Jose area and the limited start-up packages that were available. While selected candidates indicated that they very much liked the Department, our offers were turned down for financial reasons. An increase in starting salary and in the amount of start-up funds would greatly enhance our ability to recruit.

The Department’s ratio of tenure track to part-time faculty has been approximately 8.5 to 3 FTEF over the last five years, but will be reduced significantly in the next academic year with retirements. Because of the large number of GE offerings, this ratio has been satisfactory, although the impending retirements will put more strain on the tenured/tenure-track faculty. While assigned-time has generally been around 1 FTEF, that amount of assigned-time has not restricted course offerings in the majors or graduate program as typically the faculty member’s GE teaching load has been taken over by a part-time instructor.

2.3 Space Needs

Because of the large number (range: 11 to 17, with higher numbers recently) of introductory laboratories taught by our graduate students, it would be very helpful to have a centralized office room where all the T.A.s could be accessible to students during office hours. Currently, the T.A.s are scattered, with many squeezed into the Mineral Collections room. Because of the large number of rock samples collected in the course of field trips and research, additional space designed for rock storage is desperately needed. Other space needs include a room with large tables for students to work on maps and laboratory space for new hires.

2.4 Overworked Support Staff

Our head technician, Ginny Smith, is extremely overworked. She is very conscientious and spends large amounts of time as our computer guru, finance minister, and logistics person. In addition, she is also supplying IT assistance to other departments in the COS. Some of her duties need to be assigned elsewhere to relieve her from all the unpaid overtime. It would also help if specific hours were designated for her to work in Geology and others in COS. Our preferred solution is to have her (and other staff) be full-time in the Department. Hiring a student assistant to help with preparations for the now-split-session Geol 129 (field camp) would ease the double workload of preparing the field equipment. In addition, the office staff was cut from a full time position. The position was recently increased from quarter time to half time, but that still provides inadequate coverage of the office administrative needs.
Part 3: Program Synergies

3.1 Possible interdisciplinary program in Sustainability/Climate Change

The Department envisions an interdisciplinary program in Sustainability and Climate Change (SCC) to meet a growing student interest in these topics and serve a significant societal need for trained professionals prepared in the broad range of subjects needed to address sustainable resource use and the impacts of climate change. The program would integrate existing courses and expertise in several SJSU departments, such as Geology, Meteorology and Climate Science, Environmental Studies, Biology, and Communication Studies. At the outset, the program might simply provide a recommended sequence of core courses in a SCC concentration. Some courses would be housed in single departments; others would be team-taught, as is the case with the existing Global Climate Change course (COMM/ENVS/GEOL/METR 168). As the program develops, participating faculty and departments may design a stand-alone certificate or degree program in Sustainability and Climate Change. A coordinated interdisciplinary SCC program would strengthen grant proposals submitted by participating faculty to federal and private funding sources.

3.2 Connections Across Campus

The Department teaches several classes that are cross-listed and/or team taught with other colleges on campus, including the Global Climate Change course described above, Geol 111 with Environmental Studies in the College of Social Sciences, Geology 142 and 242 with Biology in the College of Science, Global Studies 1B in the online Global Studies program, and Geol 174 with Civil and Environmental Engineering and Chemical Engineering in the College of Engineering. A large number of Biology majors also enroll in the GIS/GPS course (Geol 137) because of its usefulness in biological studies. In addition, the Department of Civil and Environmental Engineering recently approached the Department about teaching a 3-unit service course for their undergraduates (about 70 per semester) in Engineering Geology. The Department and Civil and Environmental Engineering are currently working on content matter with a projected class offering in Spring 2013.

3.3 Increasing Existing Ties

While the Department already interacts with the U.S. Geological Survey, through graduate student thesis projects, presentation of research results of mutual interest at the Survey and at the Department’s Monday Geology Club meetings, and other research collaborations, we are examining ways to increase our interactions. Furthermore, some of our graduate and undergraduate students are gaining valuable experience working part-time at the Survey through student appointments. Similarly, we have interacted with Moss Landing Marine Laboratories in the past, and we expect scientists at MLML would be open to proposals for collaboration on both research and course offerings. A proposal is being discussed for a joint course in geologic oceanography between faculty in the department and MLML faculty. Interactions with the Santa
Clara Valley Water District and the Alameda County Water District have led to thesis projects as well as hiring of our students.

On campus, we are already pursuing closer ties with the Department of Biological Sciences, particularly through the link of paleontology, but that collaboration could be expanded, particularly if the Sustainability/Climate Change program were to be developed. There have been discussions of a joint concentration focused on evolutionary biology. There is also an existing collaboration on climate issues between faculty in Geology and Meteorology. The Department faculty further feels that there would be mutual advantages to increased interactions with the College of Engineering, particularly with Materials, Chemical, Civil, and Environmental Engineering, many of whom would be involved in the proposed Sustainability/Climate Change program.

3.4 Science Education

Faculty members Messina and Metzger have split appointments in the Science Education program; Metzger was director of the program for several years. Their many years of experience have enabled them to develop extensive ties and collaboration with colleagues in other departments in the College of Science, and in SJSU’s College of Education. Currently, Metzger is co-P.I. with Eugene Cordero (Meteorology and Climate Science, COS) and Grinell Smith (Elementary Education, COE) on a multi-year grant from NASA for environmental education.

The Department of Geology offers courses in teacher preparation at both the undergraduate (Geol 103) and graduate (Geol 204) levels.

Metzger and Sedlock are co-directors of the Bay Area Earth Science Institute (BAESI), a long-standing, highly successful program that provides professional development in the geosciences for local teachers of grades 4 through 12. Since 1990, BAESI has served over 2000 teachers via one-day workshops and field trips and multi-week workshops. BAESI works closely with the U.S. Geological Survey and industry representatives.

3.5 Interactions with the Community

Students from the Department have made presentations at local middle schools and high schools, collected donations for charities through the Geology Club, and served at local meetings such as the Santa Clara County Gem and Mineral Society. Faculty members have also given talks at local K-12 schools, made numerous public presentations to the local community (e.g., at King Library, Children’s Discovery Museum, Guadalupe-Coyote Conservation District, Cupertino City Office of Emergency Services, San Jose Rotary), and have served on public organizations (e.g., Science Advisor to the Children’s Discovery Museum, Gilroy General Plan Committee). They have also served as judges at science fairs and participated in careers days at local schools.

3.6 Interactions with other Universities/Colleges

Departmental faculty interacts with faculty and programs at a number of Bay Area universities, including Stanford and San Francisco State. A faculty member serves as one of two university representatives on the CSU-wide initiative, Council on Ocean Affairs, Science and Technology (COAST). On a national scale, there are research collaborations with MIT, Florida
Part 4: WASC Program Outcome Rubric

4.1 Comprehensive List

The Department’s Comprehensive List is Developed

The Comprehensive List has reasonable outcomes and direct expectations for the M.S., B.S., and B.A. degrees that are compatible with the broad categories of gaining geological knowledge and skills, written and oral communication, critical thinking, and information and quantitative literacy. Expectations for M.S. students are clearly higher than those for the Undergraduate degrees. There are no national disciplinary standards, but the outcomes are in part designed to meet the expectations of the California State Licensing Board for Professional Geologists.

The undergraduate SLOs 1, 4, 5, and 6 and graduate SLOs 2, 4, and 5 specifically address student ability to understand concepts and content of geological topics. The level of sophistication increases with the graduate SLOs; for example, undergraduate SLO 2 (using scientific method) and graduate SLOs 2 and 4 (solving sophisticated geological problems) touch on broadly similar themes, but the requirement of a M.S. thesis for all graduate students leads to a much higher level of achievement. Written and oral communication are addressed by undergraduate SLO 3 and graduate SLOs 1 and 3, again with an increase in depth for the graduate program. Critical thinking is an important component of most of the SLOs, and particularly SLOs 2, 4, 6, and 7 for the B.S./B.A. program and 2, 4, 5, and 6 for the graduate program.

The main shortcoming of the objectives is that the faculty has not developed formal standard criteria for evaluating the level of student mastery of individual outcomes. We intend to develop a grading rubric for oral presentations and written assignments in our upper-division courses in the Spring 2012 semester, for implementation in Fall 2012.

4.2 Assessable Outcomes

The Department’s Assessable Outcomes are Emerging, with Many Characteristics Developed for the M.S. Program

All of the undergraduate learning outcomes explain in a general sense how students can demonstrate their learning. This is primarily done by stating what classes allow students to meet the individual outcomes, but some of the outcome assessments are perhaps too qualitative. For example, many assessment statements refer to students developing skills by applying them in geologic situations with instructors evaluating skills and providing feedback. We will strengthen the assessment by developing rubrics for some classes and more specifically outlining
expectations in greensheets in all classes that meet a particular SLO. For example, in Geology 120 (Mineralogy) the greensheet would state approximately how many minerals a student will be expected to learn as well as the grading expectations for tests/labs involving classification (SLO 5). We plan on achieving “Developed” status for Assessable Outcomes by Fall 2012.

The M.S. outcome assessments range from relatively vague to specific. Qualitative statements similar to those for the undergraduate SLOs are made, although the successful completion and rigorous evaluation of a M.S. thesis (required of all M.S. students in Geology) by a three-member committee is in our view a strong form of assessment for most of the SLOs. Some of the SLOs, such as #3 (present results of scientific research in oral format), are more explicit, as all M.S. graduates must present the results of their research to the Department as part of the weekly speaker series, and these are evaluated by the committee and the faculty as a whole. The Department has developed an evaluation form for the speaker series, which is now being used for thesis presentations.

4.3 Alignment

The Department’s Alignment Plan is Developed

The undergraduate program is designed so that students receive an increasing degree of sophistication as they advance through the curriculum. The Department has developed a curriculum “road map”, which shows three tiers of required classes that satisfy the seven SLOs: 1) Introductory Level; 2) Reinforcement; and the 3) Capstone experience (Geology 129) where students synthesize material in a 4-week field geology course. Students are required to take the introductory classes first before moving on to all subsequent required classes, and the capstone course should be the last class taken before graduation. A similar “road map” has been developed for the M.S. program, which utilizes classes that meet the Graduate Writing Requirement, the required graduate seminar, thesis writing, and the oral presentation (thesis defense). To attain “Highly Developed Status,” a clearer explanation of grading and student support services is needed. We intend to work on this “explanation” in Fall 2012.

4.4 Assessment Planning

The Department’s Assessment Planning is Developed

At the time the SLOs were developed by the Department, a multi-year assessment plan was written. Data collection has followed that plan. In the plan, SLOs were presented in a matrix of required courses and the corresponding SLO to be assessed in the course. The level at which the BS/BA SLOs were to be evaluated was assigned to the “Introductory” or “Reinforcement” category depending on the course’s occurrence in the sequence of courses in the major. The results of the assessment have been reported annually for the SLO(s) to be assessed in a given year, according to the schedule. These results are reported to UGS in the Program Assessment Report. That report details how the SLO is incorporated into that specific course and what portion of the students enrolled achieved adequate mastery of that SLO. The report also
documents modifications made to the course to improve mastery of the SLO. Further, the results of the modifications are evaluated for evidence of enhanced student learning.

The evaluation of the MS SLOs is more complicated since many of the MS outcomes are primarily related to the thesis work. We have been completing the annual Program Assessment Report for the SLO corresponding to each year, but often the assessment does not fit well into the standard reporting format of Evidence of Learning, Changes to Pedagogy, and Evidence After Changes. This is because each individual thesis advisor works independently with each MS student, tailoring the learning experience to that individual student’s strengths and weaknesses. This on-going, dynamic relationship works well, as evidenced by the Department’s reputation on campus for producing high-quality theses and the number of our theses that have won the University Outstanding Thesis Award.

As the Department completes the first cycle of evaluating the SLOs since developing the assessment plan, it will be examining the success of that plan as part of its Program Plan review. The Department proposes to produce several rubrics on a trial basis to see how they function. We will begin with rubrics for writing, oral presentations, and math competency for undergraduates. At the graduate level, we will begin with rubrics in writing and oral presentation. These rubrics will be developed by the early Fall 2012 semester and implemented that semester. The Department will make any changes to rubrics and to the assessment plan if it becomes clear that they are necessary.

4.5 The Student Experience

The Department’s Student Experience is Emerging

Students are somewhat aware of the SLOs, although most of this awareness is a function of their interaction with individual faculty members. Relevant BS/BA SLOs are stated on the greensheets for the respective core courses and discussed at the beginning of the semester. The Department plans to begin including a discussion of all of the undergraduate SLOs in GEOL 120 (Mineralogy), the first course in the sequence that almost all majors will take at SJSU, be they continuing or transfer students. This will make expectations clearer earlier in the major. The Undergraduate Advisor also addresses the SLOs in individual discussions with advisees. For the MS SLOs, the primary way that students become aware and evaluate their own progress is through interaction with their thesis advisor, and to a lesser extent the other members of the thesis committee, as most of the SLOs are evaluated through thesis research work. The indirect consequence of the informality of making SLOs known to students is that the students may not be aware of the relationship between how they are assessed and the SLOs that apply to a certain course or activity.

We will involve students (specifically, the officers in the student-run Geology Club) in the development of the rubrics for oral presentations. Students will use the rubric for oral presentations to evaluate class or thesis talks by other students. In addition, students in the BS Capstone field experience (Geol 129), taken at or near the end of their studies, will be asked to self-evaluate their own abilities to meet the undergraduate SLOs.

The respective Curriculum committees (Undergraduate for the BS/BA, Graduate for the MS) will develop a plan to increase student awareness of SLOs by involving them, on a course-by-course (for the BS/BA) or thesis-by-thesis (for the MS) level, in defining what it means to be
competent in a certain SLO. They will then evaluate themselves with respect to their individual competency in each relevant SLO at the end of the semester.

The Department will post the SLOs on links on the respective programs (BS/BA or MS) on the web pages of the Department’s website. This will allow students to see the Department’s expectations before applying or early in their time in the Department. We plan on achieving “Developed” status for the Student Experience by the end of AY12/13.

Part 5: Student Learning in Program

5.1 Evaluation of Student Learning for SLOs

The Department of Geology identified the following learning outcomes for the undergraduate degree programs:

1. Develop the skill to read and accurately interpret topographic maps.
2. Use, formulate and test multiple working hypotheses based on scientific method.
3. Effectively communicate scientific ideas and results, both verbally and in writing.
4. Use the fundamentals of chemistry, physics, math, and computer science to solve geologic problems.
5. Classify and identify geologic materials, including soils, minerals, and rock.
6. Visualize and comprehend geologic structures and process in 4 dimensions (3D plus time).
7. Understand the interactions of the solid earth with the hydrosphere, atmosphere, and biosphere, and the effects of those interactions on human kind and the environment.

Assessment of these SLOs indicates that the students achieve a high level of competence in SLOs numbers 1, 2, 5, and 6, while requiring more reinforcement in SLOs numbers 3, 4, and 7. With respect to SLO number 4, the students typically are not able to apply basic science skills at the expected level at the beginning of the semester, but they are able use them acceptably by the end of the course. The Department proposes to modify SLO number 4 to replace computer science with biology, as being a more relevant fundamental science for geologic problems. The last part of SLO #7 will be modified to read “…effects of those interactions on earth history, humans, and the environment.”

The Department has identified the following learning outcomes for the graduate program:

1. Demonstrate scientific writing of acceptable quality.
2. Formulate scientifically sound and logistically reasonable plans for solving geologic problems.
3. Demonstrate ability to present results of scientific research orally.
4. Develop ability to apply modern laboratory and field investigation techniques to solve sophisticated geological problems.
5. Develop skills and knowledge to make use of scientific data and resources to support investigations.
6. Develop ability to think analytically.
The most problematic area of these graduate SLOs is the quality of the scientific writing, particularly with non-native English speakers. This has been addressed recently as part of the program review by increasing the minimum score required on the TOEFL exam from 80 to 90. In addition, the required Statement of Interest in the graduate application has been expanded to a longer and more detailed format to better assess an incoming student’s competency in writing, and the form for letters of recommendation now specifically asks for an evaluation of the student’s ability to write a satisfactory M.S. thesis.

5.2 Development of Rubrics for Program Level Outcomes

The Department will be developing rubrics for undergraduate writing, oral presentations, and math (SLOs #3 and part of #4) in order to a) clarify for students the Department’s expectations, and b) to evaluate the student’s progress towards achieving competency in the SLOs. In addition, the Department proposes to develop rubrics in graduate-level writing and oral presentations (SLOs #1 and 3). These rubrics will be developed by early Fall 2012 and evaluated that semester. Any modifications to the rubrics will be made following this evaluation. Sections 4.4 and 4.5 provided additional detail on the rubrics.

5.3 Evaluation of Internal Assessment Process of Student Learning

The assessment process for the SLOs needs to be formalized to a greater degree. Undergraduate SLOs are assessed in the context of specific courses, but the resulting assessments are not regularly discussed by the Faculty to determine how any shortcomings could best be addressed. M.S. SLOs are mostly evaluated in the context of the program as a whole. Since the outcomes are formally assessed (sent to UG Studies) in the Spring semester, we plan to reserve one of the later Faculty meetings each Spring to discuss the results of the formal assessment and SLOs in general. This discussion was recently carried out for the B.S./B.A. and M.S. SLOs assessed in Spring 2012.

The graduate SLOs are also evaluated relatively informally by each graduate advisor via the Master’s thesis. Based on the high quality of the theses produced, this approach appears to be working well and does not need to be more formalized.

5.4 Effectiveness and Currency of Pedagogy

The Department judges that its pedagogy is both effective and reasonably current, although it is kept this way by constantly updating the course content and teaching approach to accommodate different styles of learning. The involvement of graduate students and, increasingly, undergraduate students in research augments the classroom pedagogy by having them actively solve real geologic problems over an extended period of time. Requiring the thesis of all M.S. students assures an in-depth experience at the graduate level.

One factor that would improve the currency of the content would be an update of software (e.g., seismic processing and groundwater modeling), classroom computers/projectors, and instructional and research equipment (see Sec. 2.1). It is very difficult to stay current with outdated or missing equipment and software. Having additional technician support to set up and
maintain laboratory equipment and exercises would allow the faculty to focus on lab content rather than logistics.

5.5 Cultivating Global Citizens

Global citizens need scientific knowledge and skills to address global issues. The Department concludes that it provides all students (GE, majors, graduate students) with level-appropriate information to understand problems in the global physical environment. Furthermore, the BA majors will carry this exchange of knowledge further when they become teachers and share what they have learned with their students. The BS majors and MS students develop a number of skills sets that enable them to directly address global issues in water, energy, and materials resources, as well as insights into the consequences and mitigation of global climate change.

5.6 Developing Skills of a Global Citizen

Geology and earth science instruction are generally problem-driven, requiring students to integrate and analyze complex sets of data and information. This helps the students to develop the critical thinking and problem-solving skills needed by global citizens. Many of the laboratory exercises in GE, major, and graduate classes require students to work as groups, helping them learn successful team-building practices. Many courses require semester reports that synthesize activities or research, requiring the organization of written information in a clear and cohesive manner—an important skill of the global citizen. Similarly, at least half of the major classes require oral presentations summarizing the reports, further enhancing communication skills.

5.7 Action Items Developed from Evaluation

The following action items have been developed from the evaluation of student learning:
1. Review the results of the evaluation of individual undergraduate SLOs during a Faculty meeting in the Spring semester;
2. Modify the requirements for the written Statement of Purpose for the graduate application;
3. Include a list of SLOs in the greensheets of relevant classes and a class discussion of all undergraduate SLOs in Geol 120;
4. Prepare rubrics for
   a. Graduate scientific writing ability
   b. Graduate oral communications skills
   c. Undergraduate math skills
   d. Undergraduate oral communication skills;
   e. Undergraduate written communication skills, and
5. Seek funding for equipment and software update and acquisition.
Part 6: Required Data Elements

6.1 Problem Areas

The statistics on enrollment, retention and graduation are given in Appendix A. These were provided by the SJSU Office of Institutional Research. While the new students enrolled each academic year can be highly variable (Figure 1), the total enrollments (Figure 2) have increased over the last five years, particularly at the graduate level (SJSU has historically had the largest CSU Geology graduate program in northern California). While few undergraduates come to college expecting to major in geology, they are often inspired by a GE class to switch majors. This is also true at the graduate level where students with backgrounds in other disciplines (e.g., engineering, mathematics, physics or biology) switch to geology for graduate work. We would particularly like to increase undergraduate enrollment. In the past we have interacted with colleagues at local community colleges to inform their students about the SJSU program; reaching out to those colleagues on a regular basis could increase the number of transfer students entering the program.

![Figure 1. Students newly enrolled in a given academic year.](image-url)
The undergraduate student population for majors has been dominantly male (averaging 70%) while the graduate student population has been dominantly female, although the percentage of male graduate students has been increasing over the last five years (from 27% to 46%).

In terms of undergraduate students reporting their ethnicity, about 12% have been Asian over the last five years and 15% have been Hispanic. There have not been significant upward or downward trends in the ethnic mix. The percentage of foreign students has increased from 0 to about 4% over the last three years. At the graduate level the student population is 6% Asian, 15% Hispanic, and 13% foreign, without any particular trends. Recruiting students from local community colleges could increase the diversity of our student population.

The average retention rate among Geology students based on F06 – F10 data are as follows: 73% for first time freshman, 98% for new transfer students, and 84% for graduate students. These rates seem good. The graduation rates indicate that it generally takes students longer than expected to graduate, with only 33% of freshmen graduating with their cohort. The percentages for transfer and graduated students are 53% and 37%, respectively. There are reasons for each of these low timely-graduation rates, often having to do with the requirements for supporting courses in mathematics, physics, and chemistry for students coming to the program from other majors. Also, the sequence of courses in the major can be difficult to finish in two years for transfer students who come in with minimal scientific background. At the graduate level, the additional course work to make up deficiencies for students switching to geology from other disciplines can account for part of the long time to finish. In addition, the thesis program is quite rigorous and sometimes the field seasons can be short, delaying the date of thesis completion. An additional issue at the graduate level is that many of our students take jobs before completing the thesis, making it difficult for them to complete the thesis in a timely manner. The undergraduate and graduate advisors will continue to advise students as effectively as possible to make progress towards graduation at a reasonable rate.
6.2 Progress towards University or College Strategic Plan Goals

The proposed development of a Sustainability and Climate Change program fits well with both the Dean’s and previous Provost Selter’s emphasis on interdisciplinary studies, and with current Provost Junn’s emphasis on Centers of Excellence. The Department could potentially contribute to additional Centers of Excellence relevant to California issues, including to centers focused on natural hazards mitigation, water resources, or excellence in science education.

We will involve students (specifically, the officers in the student-run Geology Club) in the development of the rubrics for oral presentations. Students will use the rubric for oral presentations to evaluate class or thesis talks by other students, as well as for self-evaluation.

Provost Junn’s emphasis on the effective use of technology is addressed by the large number of online courses offered by the Department as well as the mixed-mode delivery of a number of courses that utilize Desire2Learn to deliver course content, exams, and grades, and/or to facilitate student interactions through Discussion boards.

Part 7: Summary

The Department of Geology judges that it does a good to excellent job of preparing students for successful professional careers in the discipline and in teaching, particularly given the fiscal limitations that a) make hiring difficult, b) impede the use of state-of-the art equipment, and c) cause the support staff to be overworked. The collegiality and productivity of the Faculty, both tenure-track and part-time instructors, the high quality of our M.S. theses, and support for the SJSU, scientific, and broader local community are areas of particular pride. We intend to increase student awareness of the SLOs and produce selected rubrics to aid in the assessment of those SLOs. We will also seek ways to augment the undergraduate enrollments through contacts with local community college instructors and to facilitate progress towards graduation for the students enrolled.

A major challenge for the Department is the number of faculty who will be retiring in 2012 and the five years that follow. It will be critical for the Department to fill these positions to maintain the quality of the program and to allow it to take a lead in new avenues of interdisciplinary teaching and research, as outlined above.
TO: Dr. Dennis Jaehne, AVP, Undergraduate Studies

FROM: Dr. Karen Grove, Professor and Department Chair, San Francisco State University Department of Geosciences

DATE: 9 January 2013

SUBJECT: Report of external reviewer for Academic Program Review—San José State University Department of Geology

Upon request by San José State University (SJSU) administrators, and in the context of providing evidence for the University’s Academic Program Review process, I on 14–15 November 2012 visited the SJSU campus where I talked with campus administrators and members of the Geology Department. During the two days, I had extensive discussions with Geology Department faculty, lecturers, staff, and students. Prior to the visit, I read the Department’s Self-Study document that was produced in Spring 2012.

In this report, I present the results of my conversations during the two days. Results are abstracted in an Executive Summary, and described in more detail in subsequent sections. The organization of the report is listed below:

- Executive Summary
- Collegial relationships
- Efforts to increase numbers of students and their diversity
- Quality of undergraduate program and assessment of Student Learning Outcomes
- Quality of graduate program and assessment of Student Learning Outcomes
- Faculty present and future
- Administrative and technical staff support
- Instrumentation and other resources
- Interactions beyond the Department and the University
Executive Summary

The Geology Department at San José State University is a collegial department that is very well functioning, particularly considering the high teaching load and continuing CSU-wide budget cuts. Student enrollments have increased slightly, but are still low, compared to other departments. This is a nation-wide problem that arises from students’ lack of exposure to the field; the low numbers do not negate the importance of the field and a shortage in trained geosciences is already occurring in some areas. Because of the need, Department graduates are readily hired into agencies and firms, mostly in the San Francisco Bay Area. The program has an excellent reputation in the Bay Area for producing well-trained geologists. Department graduates have also been accepted into a wide range of MS and PhD programs, both locally and nationally.

Undergraduate and graduate students are well trained to enter the geoscience workforce. The Department may wish to consider developing closer ties between their alumni and current students, who want to know more about their career opportunities. Specific recommendations are made to simplify and improve the Student Learning Objectives (SLOs) for both the undergraduate and graduate programs. Graduate students have excellent opportunities to gain teaching experience as Teaching Assistants; however, they would benefit from some training about teaching pedagogy and dealing with problems that arise in the classroom. Graduate students would also benefit from a course focused on helping them to write their research proposal and to improve their writing skills.

Departmental faculty members are very active professionally, and they have numerous interesting research opportunities for students. There will be much faculty turnover during the next 10 years, and the Department will need to develop a strategic plan for its future. In line with national trends, they may want to expand beyond the traditional fields of geology and seek new hires that have more interdisciplinary interests in the geosciences, including links to other fields. The Department has already been revising courses to enhance their Earth Systems approach and is adding courses that are useful to other programs such as engineering. Especially with new faculty hires, the University needs to figure out how to lower the teaching load and provide better start-up packages, if they want the faculty to develop strong, externally-funded research programs.

The Department’s administrative and technical staff are highly capable but overworked. A solution needs to be found for this problem. Much of the research equipment is old and hard to maintain. Departmental faculty may want to seek external funding and work with other departments and institutions to expand the available instrumentation. Existing collaborations, such as with the U.S. Geological Survey, already provide additional opportunities for students within the Department. Programs such as BAESI create valuable connections with local K-12 schools, and help to attract students to the field.
Collegial relationships

In conversations with members of the Geology Department, it was clear that the unit functions well, and that there are collegial relationships among all Department members. Almost everyone feels overworked, and decreasing budgets have added many challenges, but at least faculty and staff are able to work together to address these challenges. There is a feeling that everyone is doing their share to contribute. Lecturers, who can sometimes feel undervalued in a department, describe themselves as a “happy bunch”. The administrative and technical staff feel like integral and highly valued members of the Department. Students also sense the camaraderie that pervades Departmental activities. Challenges for the Department are addressed in subsequent sections, but any solutions should strive to maintain the Department in its well-functioning state. Mergers with other departments may not be the ideal solution to the challenges.

Efforts to increase numbers of students and their diversity

One of the big challenges for any geology department is the number of majors and the diversity of those majors. Unfortunately, this is a systematic problem that arises from several nationwide realities. The American Geological Institute in Washington, D.C. collects and analyzes extensive amounts of data about the geosciences from K–12 to workplace levels; their most recent analysis is a 171–page document that shows the current situation and historic trends: Status of the Geoscience Workforce 2011 (http://www.agiweb.org/workforce/reports.html). A few relevant highlights are:

- Compared to other STEM fields (biology, chemistry, physics, math), few students take geology or earth science courses in high school. Because they are not exposed to the field at the high-school level, most students do not know it is a career option (although job prospects are excellent, according to the Bureau of Labor Statistics—http://www.bls.gov/ooh/life-physical-and-social-science/geoscientists.htm).
- Because of historical perceptions that bare little relationship to the current state of the field, earth science courses are presented at a low level that don’t attract students on a rigorous academic track. There are no AP geology or earth science courses, and the mean SAT Math scores for students with geology or earth science courses is lower than the scores for those taking biology, chemistry and physics. Universities, such as the University of California system, do not count geology/earth science as a prerequisite lab course for entry.
- At the national level, geoscience remains the least diverse of the STEM fields. Despite concerted efforts to increase diversity within the various geoscience fields, the percentage of geoscience degrees conferred to underrepresented minorities at undergraduate and graduate levels remains below 7%. Because the fields are relatively unknown among the general populace, it is particularly difficult to attract students who may be the first in their family to enter college, and whose family pushes them to enter a field that is viewed as more prestigious.
As described in the most recent report of the Bureau of Labor Statistics (http://www.bls.gov/ooh/life-physical-and-social-science/geoscientists.htm), “employment of geoscientists is projected to grow by 21 percent from 2010 to 2020, faster than the average for all occupations.” Salaries are high—the median annual wage of geoscientists in May 2010 was $82,500. Because of this, graduates of the SJSU Geology Department get jobs and go on to successful careers. However, because of the nationwide situation described above, it remains difficult to increase the number of students and their diversity. As a result, a large shortage of geosciences is projected for the future as many of those currently in the workforce enter retirement.

Within this context, the Geology Department is doing quite a bit to attract more students to the major. They are doing outreach to K–12 levels via the Bay Area Earth Science Institute (BAESI, since 1990) where they work with local teachers to provide professional development in the geosciences. Students and faculty have given talks for local schools and public organizations. All of these efforts raise the awareness of geology as a field of study. Department faculty teach courses to train future Earth Science teachers. They have recently added courses that are cross listed and/or team taught with Biology and Environmental Studies. They have also created a service course in Engineering Geology for the Civil and Environmental Engineering program. All of these connections, with the community and other departments, help raise the awareness of geology as a career option and can help attract students to the major. In line with national trends, the Department has seen a slight rise in undergraduate majors and a larger rise in graduate enrollments (Figure 2 of Self-Study document).

The Department’s Self-Study document describes the possible development of an interdisciplinary program in Sustainability and Climate Change to integrate expertise in a variety of university departments. They have already revised introductory-level courses to enhance a “earth systems” approach, and have added a capstone course in Earth Systems. The interdisciplinary program seems like a potentially useful avenue to pursue, given that it would build on existing faculty expertise and would help show the importance of the geosciences in addressing areas of student interest and great importance for our planetary future. The revised courses with an Earth Systems approach would fit well with such a program. However, the Department would need to gain more expertise in areas such as climate, because most of the current faculty members are trained in more traditional areas of geology.

**Recommendations.** Because there will be substantial faculty turnover during the next 10 years, I would recommend that the Department seek faculty who can work across disciplines and whose research addresses issues related to sustainability and climate change. I would also recommend that they examine their majors curriculum and look for ways to provide more flexibility for those wanting to study topics that extend beyond the traditional geology subjects.
Quality of undergraduate program and assessment of Student Learning Outcomes

SJSU’s Department of Geology has for many years had an excellent reputation within the San Francisco Bay Area for producing well-trained geology students. Department graduates are well represented in local consulting firms, government agencies, and other employment sites. The Department has retained a traditional curriculum that well trains students in all of the basic subjects they need to achieve acceptance into graduate school and/or employment, including the background needed to take the ASBOG national exam and be licensed as a Professional Geologist. An honors course provides interested students with the opportunity to do research at the undergraduate level.

Although many Department graduates are employed in the Bay Area, there seems to be only minimal effort applied to involving those alumni with current activities and students. In conversations with students, some complained that they lacked knowledge about opportunities after they graduate. They would like more help in finding jobs and internships.

**Recommendation.** I would recommend strengthening alumni relationships, with more connections between alumni and current students, which can be a very effective way to help current students learn more about career opportunities.

I have reviewed the Department’s Student Learning Outcomes (SLOs) and how they have been evaluated. It appears that the Department has done a good job assessing the most concrete of the SLOs. For example, changes were made in courses to help students better “visualize and comprehend geologic structures and process in 4 dimensions (3D plus time)” (SLO #6), an essential element of a geologist’s training. Similarly, activities in courses can readily address students’ abilities to “develop the skill to read and accurately interpret topographic maps” (SLO #1) and “classify and identify geologic materials” (SLO #5).

However, I found several of the SLOs to be excessive “overarching” and difficult to assess. SLO #2 is “use, formulate and test multiple working hypotheses based on scientific method”. While this is highly appropriate for graduate students, and can be assessed on the basis of their MS research and thesis, it was not clear to me how this SLO would be assessed in the undergraduate program. SLO #7 is “understand the interactions of the solid earth with the hydrosphere, atmosphere, and biosphere, and the effects of those interactions on human kind and the environment”. While desirable as an outcome, this overarching SLO seems difficult to measure. Apparently the Department implemented a new capstone course and used “pre” and “post” exams to measure improvement. I could not find the specific results, but it seems to me that this SLO needs to be broken down into an outcome that is more tangible and easy to measure.

Two other SLOs seem reasonable but I was unclear about how they were being assessed. SLO #3 is “effectively communicate scientific ideas and results, both verbally and in writing”. Assessment could be accomplished by a series of courses that included culminating writing products that are progressively more advanced. To assess verbal
communication, however, is much more difficult. SLO #4 is “use the fundamentals of chemistry, physics, math and computer science to solve geologic problems”. This is a highly desirable outcome; assessment could be achieved by evaluating a series of assignments that aimed to apply math and science principles to solving geologic problems.

**Recommendation.** To make assessment more manageable, I would recommend eliminating SLO #2 at the undergraduate level. I would recommend eliminating or greatly simplifying SLO #7, and removing verbal communication from SLO #3. The remaining SLOs are appropriate and can be measured by evaluating a series of assignments in required majors courses. The Department may choose to focus on one SLO at a time, rather than trying to do all of them at once. They have already discovered that trying to write rubrics to assess 5 SLOs is a much larger job than anticipated. One issue appears to be student knowledge and “buy-in” of program SLOs. The Department may wish to consider using electronic portfolios that require students to select materials from their courses that address each SLO. The SLOs then become more meaningful to the student who at the end of the college experience has a concise summary of what they have learned.

**Quality of graduate program and assessment of Student Learning Outcomes**

As described in the previous section, the Department is well known in the Bay Area for producing well-trained geology students who are currently employed in many companies and agencies. At the graduate level, all students complete an independent research project, in conjunction with a faculty advisor, and they write a Masters Thesis. Collaborations with scientists locally (e.g., U.S. Geological Survey) and beyond (at other universities) provide students with opportunities for a wide range of research topics. In my initial meeting with administrators, I was surprised to hear that the Department keeps student and faculty research separate and so I focused on addressing this issue during my conversations with faculty and students in the Department.

I found that faculty and student research are highly integrated; in fact, it seems that all MS student research is done in close collaboration with the faculty and their collaborators. Faculty spend large amounts of time, particularly in the summer, working with their students in the field and laboratory. Faculty encourage their students to present their research at professional conferences and work closely with them to write up the results of their research. As a result, Department students have received 8 first place awards for University Outstanding Thesis and 1 second place award. This is an impressive accomplishment, particularly given the relatively small number of graduate students in the Geology Department.

**Recommendation.** It seems that the Department needs to do a better job of highlighting their students’ accomplishments. In the Department’s Self-Study, there was a list of faculty publications and grants, but no indication of their students’ accomplishments, for example, as authors of peer-reviewed publications, presenters at meetings, or the grants they received.
I have reviewed the SLOs for the graduate program. SLO #6 seems unmeasurable; how does one measure a student’s ability to “think analytically”? SLO #1–5 are the outcomes that would be expected in any graduate program where students do independent research. The demonstrated quality of the graduate theses indicates that students are achieving these outcomes. While developing the research project idea, students write a research proposal and also complete an oral exam about their topic. This provides an excellent opportunity to assess several of the SLOs. There appears to be some concern about the quality of students’ writing and the amount of work faculty must expend to help students complete their written theses.

**Recommendation.** The Department may wish to consider adding a research methods course where students write their research proposal, with guidance from the course instructor as well as the thesis advisor and committee members. Students can also do peer reviews of each others’ proposals and, as a result, they also learn more about the various types of research that is occurring in the Department. Such a course also helps to improve students’ writing skills, an expressed concern of Departmental faculty. The Department should probably eliminate SLO #6 and focus on concrete elements such as SLOs #1–5 that can be measured.

In my meetings with students, most of whom were graduate students, we discussed their experiences as Teaching Assistants (TAs). I was surprised to hear that students at SJSU get tuition waivers during the semesters they work as TAs. This is an excellent benefit that few CSU campuses enjoy and it is certainly help recruit better students for the program. Their only complaint about this is that they have to pay first and get reimbursed later. The problem is that they are not informed in advance that this is the procedure.

**Recommendation.** When students are admitted, students who will be hired as TAs should be clearly informed about the procedure for tuition waivers; that is, they will have to first pay for tuition and then get reimbursed later.

Currently, 18 MS students are hired as TAs. This is a fabulous opportunity for graduate students to gain monetary support and teaching experience. The students expressed varied opinions about their experience as TAs. Some are teaching labs associated with a lecture course and others are teaching stand-alone lab courses. Those teaching labs associated with lecture courses seemed to feel better about their experience, particularly when the lecture instructor meets with TAs every week and they are clear about the coordination between lecture and lab. Those teaching the stand-alone lab felt more “thrown in” to the class with little preparation. Basically, they feel they are on their own. All TAs said they receive no guidance about teaching strategies or what to do when situations such as cheating arise. One example given was that TAs were expected to use the “jig-saw” teaching technique but were provided no instruction about how to do this.

**Recommendation.** The Department should consider implementing a better process for training TAs and helping them develop the skills they need to teach a laboratory course. In the Geosciences Department at SFSU, we have created a 1-unit graduate course that
aims to provide TAs with support in teaching pedagogy and other issues that arise when teaching for the first time. This course has worked well to help students feel more prepared and confident in the classroom. Although it is difficult to find a time that works for everyone each week, the training can be provided during a 1-day workshop prior to the fall semester and occasional meetings throughout the semester. Regular meetings of all instructors teaching the same class (lecture+lab or multiple lab sections of stand-alone lab) greatly help to create a more cohesive experience for instructors and their undergraduate students.

In my meetings with students, we also discussed the curriculum and course offerings. In general, students feel that they would like to have more advanced-level courses, but they also understand the difficulty of offering these courses frequently. Like the undergraduate students, they would like more guidance as they prepare to enter the professional workplace after they graduate.

**Recommendation.** As expressed above, the Department may be able to better utilize alumni relationships to help provide career advise to current students. To provide more advanced-level courses, they may be able to coordinate offerings with other Bay Area institutions. Already, they have proposed a joint oceanography course between faculty in the Department and at Moss Landing Marine Laboratories. We have decided to also do a better job sharing course information between our geology/geoscience departments at SJSU/SFSU. Despite the distance, and inconvenience for commuting, we may be able to offer part of our courses via distance learning and only require students to commute one day/week.

**Faculty present and future**

Department faculty are very active professionally. They regularly attend professional conferences; they are getting grants for their research and for outreach programs; they are publishing results of their research in a variety of venues; and they are providing service to the professional community beyond the University. Faculty expertise cover the breadth of geologic disciplines so they can offer students a good variety of courses and research topics. They have established collaborations locally, nationally, and internationally, and are able to provide students with a wide range of research options.

It was surprising to learn that research-active faculty still have a 12-WTU teaching load. This is very high, given the amount of time it takes to do research—writing grant proposals, doing field and laboratory work, mentoring students, writing manuscripts, reviewing proposals and manuscripts of others. It was also surprising to learn that probationary faculty receive a reduced teaching load for only the first several years of their employment, and that they receive a very small amount of start-up funding.

**Recommendation.** To help faculty maintain active research programs, the University should figure out how to limit them to a 9-WTU teaching load. Those who are not research active would still teach 12 WTUs. Clear guidelines can establish the meaning of “research active”. In the CSU, research expectations have increased continually during
the past several decades. The University should help new faculty reach the higher expectations by giving them a reduced teaching load throughout their probationary period and providing better start-up packages.

The most-recently hired faculty member (Prof. Hendricks) has an additional problem during his probationary period—a wife who lives on the other side of the country. He is a popular instructor, and a productive researcher who has recently obtained a large NSF grant. The University has already expended a lot of resources to hire and retain Prof. Hendricks.

**Recommendation.** I would think it advisable to figure out some way to hire Prof. Hendricks’ wife, who is currently in a tenure-track position elsewhere.

Because of the age distribution of Departmental faculty, there will be substantial turnover during the next decade, as senior faculty enter retirement. This is an opportunity for the Department for think about its future direction. Expertise is spread among the various subfields of geology, with a focus on traditional fields such as petrology. These fields are important and need to be retained, but it is also important to think about linkages with other fields that will help the Department offer courses and research topics that attract students and address problems of concern to society.

**Recommendation.** As faculty members retire, the Department may wish to consider hiring faculty with interdisciplinary research and teaching experience that spans subfields and even links with other fields. The most recent hire is a good example of this, as his research and teaching has strong links with biology. Links and collaborations can help attract students to the program by demonstrating the relevance of geology to society. Problems of climate change and environmental protection are well addressed by geologic expertise and they attract students, in part, because of perceived relevance. The four areas of expertise for new hires listed in the Self-Study—neotectonics, sedimentology, low-temperature geochemistry, and hydrogeology—have strong potential for attracting students.

Teaching methods have been changing and new techniques are now available for instructors. It appears that faculty are taking advantage of new technologies by offering online courses and using the University’s online course management system, even for regular classroom-based courses.

**Recommendation.** To generate and maintain student interest, particularly in general education courses for non-majors, the Department should continue to explore new ways to integrate technology into the classroom. For example, electronic response systems (i.e., clickers) are effective ways to engage students, promote peer instruction, and make even large-sized classes more interactive.
Administrative and technical staff support

The Department has one administrative staff who is split between two departments. Like others in the Department, she feels respected by faculty and students and has good interactions with them. However, she is overworked by having to manage two departments, and she often works through lunch or doesn’t take her breaks. In addition, there are insufficient work-study funds to hire a student to be in the office during all of the times she is in the other department. This makes it difficult for instructors and students, who sometimes have no one to help them with problems that arise.

Recommendation. A full-time administrative staff person would help the Department provide better service to students and better support the faculty who are themselves overworked (the usual state of CSU faculty, it seems!). At the least, the Department needs someone in the office at all times to deal with problems that can arise at any time.

The Department has one full-time technical staff person and one person who is 50% time in the Department and 50% time in the College of Science. As with the administrative staff, they expressed satisfaction with the collegial nature of the Department and feel they have a good working relationship with everyone. However, they are severely overworked. They apparently often work overtime into the evening and on weekends to help students and faculty with research and field trips, without additional pay. I was struck by how conscientious they are, expressing concern about meeting the needs of the Department’s students. Some of their work goes little noticed, because graduate students will ask for help with their research—e.g., to create models, make rock thin sections, or deal with computer issues—and they will stay to assist the students even after regular hours.

Ginny, in particular, is highly overworked, and Departmental faculty expressed concern that her health may be challenged because of the breadth of her responsibilities. As often happens, when someone is highly competent, more work gets asked of them. Ginny not only deals with technical (mostly computer) issues for the Department and the College, but she also manages some of the budget, arranges travel, and does purchasing for the Department. As a geologist and a skilled technician, she is highly valued because she understands the Department and their needs, and she is committed to the success of its programs.

Recommendation. This seems like a crisis situation. A way should be found to reduce the workload of the staff, particularly for Ginny. Otherwise, she may suffer from burnout and be unable to contribute more to the Department.

Instrumentation and other resources

The technical staff complained that much of the equipment is very old and takes much time to maintain in working order. In some cases, the equipment is so old that parts are no longer available. The self study describes needs for new equipment and software, and vans for field trips. Like many departments in the CSU, deferred maintenance because of
budget cuts has led to an unsustainable situation for science departments that need sophisticated instrumentation to produce results. This is not an easy problem to solve, particularly because the need across the CSU system is so great. Even with money to purchase new equipment, the cut in technical staff positions makes their upkeep nearly impossible. Some interim steps can be taken that could help to ameliorate some of the need.

In the Geosciences Department at SFSU, we have had success obtaining funds for new equipment (particularly computers for teaching labs) by writing proposals to programs within the NSF’s Division of Undergraduate Education. We have also had success with joint proposals among departments within the College of Science, for example, to obtain a state-of-the-art XRD machine. The maintenance and upgrades are then shared among departments and a new college-wide committee is working to figure out ways to better support the technical equipment we have. We also take advantage of the rich scientific community we live in, and faculty and students sometimes use laboratory facilities at local institutions such as Stanford, UC Santa Cruz, and the U.S. Geological Survey.

**Recommendation.** In addition to seeking more funds for equipment from the University, Departmental faculty may wish to try writing proposals to the NSF, both by themselves and in collaboration with other departments. They may also want to look for more opportunities to use laboratory facilities in other departments or at other institutions, to avoid the problem of daily maintenance. [In the SFSU College of Science, the Dean appointed one of the Chemistry faculty to a half-time position as research coordinator. She works with faculty across the College to identify funding sources, improve their grant proposals, and potential for inter-Departmental collaborations. My sense is that the increased productivity more than offsets the cost of this half-time position.]

**Interactions beyond the Department and the University**

Because the Department has a long-lived graduate program and a faculty with strong professional relationships, they have established an extensive network of collaborations and connections. Faculty and their students do research locally and around the world. After students graduate, they go on to prestigious PhD programs and to jobs in a variety of geoscience positions. Two of the faculty have positions that are split between the Geology Department and the Science Education program; they teach classes and have collaborations that reach across campus. Departmental faculty in 1990 created the Bay Area Earth Science Institute (BAESI) that provides professional development in geosciences for local teachers and has continued to operate for 22 years—a truly impressive accomplishment. As described in a previous section, the faculty are professionally active and engage students in a wide range of research projects.

Given the teaching load, the small support staff, and the continuing cuts in equipment and other budgets, the Department is doing as well as can possibly be expected. Unfortunately, a turnaround in our fortunes is unlikely to come anytime soon, and so all departments will need to develop an entrepreneurial spirit of seeking resources through funding agencies and collaborations with other institutions.
February 27, 2013

MEMORANDUM

From: Michael Parrish, Dean
To: Ellen Junn, Provost; Dennis Jaehne, AVP for Undergraduate Studies;
Pam Stacks, AVP for Graduate Studies and Research;
Bob Miller, Chair, Department of Geology

RE: Dean’s Response to External Program Review for the Department of Geology

Dr. Karen Grove did an external review site visit to the Department of Geology in November, 2013 and submitted her report in January 2013. Her report captured the essence of this department – a strong, cooperative faculty that meet their enrollment targets largely through general education courses but struggle to get majors. Like Dr. Grove, I see little sense in combining Geology with any other small departments, but perhaps they can look at working with regional universities such as CSUEB and SFSU to boost enrollments in specialized classes. The department should also look at having a relatively inflexible roadmap for their majors and graduate courses to boost enrollments.

I also concur with Dr. Grove in the recommendation to simplify and clarify SLOs for majors, particularly for the graduate program. I appreciate that Geology faculty have been regular participants in the college assessment workshops.

Dr. Grove noted issues within the department involving deferred maintenance of aging research and teaching equipment. I agree with her that faculty should actively pursue equipment funding opportunities, but would also hope that equipment refreshes could be part of the department’s utilization of SSTEF funds.

The Department of Geology is a well-functioning unit with a strong, research-active faculty who are also very good teachers. I appreciate the Department’s efforts in conducting their self study and Dr. Grove’s efforts in her external review.
ACTION PLAN FROM PROGRAM REVIEW AND PLANNING
San Jose State University
College of Science
Department of Geology
December 11, 2013

1. Continue to implement and evaluate efforts to increase enrollment of geology majors
2. Prepare an SSTEF proposal for Dean to request monies for equipment, facility re-
   organization and technical staff.
3. Explore external resource development to fund department needs such as new
   equipment.
4. Work with Dean of Science to prioritize new hires for Geology.
5. Next Program Review Due Fall 2017

By signing below, we agree to the action plan outlined above.

________________________________________
Robert Miller, Chair of Geology

________________________________________
Michael Parrish, Dean- College of Science

________________________________________
Ellen Junn, Provost
The faculty of the Department of Geology discussed the recommendations of the external program plan reviewer (Professor Karen Grove, SFSU) during part of our pre-instructional faculty meeting on 22 January and devoted most of a subsequent meeting on 6 February to developing a plan of action for meeting most of the recommendations. We have taken a number of initial steps to deal with the recommendations, and more actions are planned after further discussion this semester. In the following, we outline actions that have been taken under the appropriate recommendation (directly quoted) of Dr. Grove.

**Recommendation.** I would recommend strengthening alumni relationships, with more connections between alumni and current students, which can be a very effective way to help current students learn more about career opportunities.

*We have scheduled a workshop as part of our weekly speaker series where alumni working in consulting firms and governmental agencies will discuss the needed skills and opportunities in their job fields.*

**Recommendation.** It seems that the Department needs to do a better job of highlighting their students’ accomplishments. In the Department’s Self-Study, there was a list of faculty publications and grants, but no indication of their students’ accomplishments, for example, as authors of peer-reviewed publications, presenters at meetings, or the grants they received.

**Recommendation.** The Department may wish to consider adding a research methods course where students write their research proposal, with guidance from the course instructor as well as the thesis advisor and committee members. Students can also do peer reviews of each others’ proposals and, as a result, they also learn more about the various types of research that is occurring in the Department. Such a course also helps to improve students’ writing skills, an expressed concern of Departmental faculty. The Department should probably eliminate SLO #6 and focus on concrete elements such as SLOs #1–5 that can be measured.

**Recommendation.** The Department should consider implementing a better process for training TAs and helping them develop the skills they need to teach a laboratory course. In the Geosciences Department at SFSU, we have created a 1-unit graduate course that aims to provide TAs with support in teaching pedagogy and other issues that arise when teaching for the first time. This course has worked well to help students feel more prepared and confident in the classroom. Although it is difficult to find a time that works for everyone each week, the training can be provided during a 1-day workshop prior to the fall semester and occasional meetings throughout the semester. Regular meetings of all instructors teaching the same class (lecture+lab or multiple lab sections of stand-alone lab) greatly help to create a more cohesive experience for instructors and their undergraduate students.

*The amount of direction of teaching assistants by the faculty lab coordinators has increased and a general meeting was held at that beginning of the semester. A more extensive training program is planned for the Fall when a new cohort of teaching assistants will arrive.*
**Recommendation.** As expressed above, the Department may be able to better utilize alumni relationships to help provide career advice to current students. To provide more advanced-level courses, they may be able to coordinate offerings with other Bay Area institutions. Already, they have proposed a joint oceanography course between faculty in the Department and at Moss Landing Marine Laboratories. We have decided to also do a better job sharing course information between our geology/geoscience departments at SJSU/SFSU. Despite the distance, and inconvenience for commuting, we may be able to offer part of our courses via distance learning and only require students to commute one day/week.

**Recommendation.** This seems like a crisis situation. A way should be found to reduce the workload of the staff, particularly for Ginny. Otherwise, she may suffer from burnout and be unable to contribute more to the Department.
The list of questions for alumni and a brief analysis of the average numerical rankings follow. Written alumni comments are below.

How would you judge the strengths of your geological education in field skills?
Average = 4.15

How would you judge the strengths of your geological education in applied geology?
Average = 3.88

How would you judge the strengths of your geological education in quantitative skills?
3.87

How would you judge the strengths of your geological education in geological/scientific writing? Average = 3.95

How would you judge the strengths of your geological education in overall breadth?
Average = 4.18

The six Program Learning Objectives for the Geology B.S. degree were also included in the survey.

1) Develop the skill to read and accurately interpret topographic and geologic maps.
   Average = 4.78

2) Effectively communicate scientific ideas and results in writing.
   Average = 4.29

3) Use the fundamentals of chemistry, physics, and math to solve geologic problems.
   Average = 4.15

4) Classify and identify geological materials, such as, minerals, rocks, and fossils, and understand their relationships to each other and interacting earth systems.
   Average = 4.52

5) Visualize and comprehend geologic structures and processes.
   Average = 4.56

6) Understand how geologists measure deep time and reconstruct earth history.
   Average = 4.50
<table>
<thead>
<tr>
<th>Year graduated from SJSU</th>
<th>Degree(s) from SJSU</th>
<th>Comments on geological education</th>
<th>If obtained a M.S. or Ph.D elsewhere how was your preparation?</th>
<th>Any additional comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>M.S.</td>
<td>B.A. Geology, Humboldt State</td>
<td>As it has been a long time since I graduated, it may have changed already, but I think there needs to be a better focus on writing. This should be a combination of technical writing, not only for technical audiences, but writing about technical subjects for non-technical audiences (i.e., I do technical work for a government agency, but most of my writing is targeted at politicians or general public who don't have the technical background)</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>B.S.</td>
<td></td>
<td>The classes I took in engineering geology, geomorphology, and hydrogeology have been most beneficial to me in my practice and career. Actually, the geologic preparation gave me an advantage in the geotechnical engineering masters program. Although, all but one of the MSCE candidates focusing on geotechnical engineering had a BA or BS in geology. We basically took over the program.</td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td>B.S.</td>
<td>Excellent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1980 and 1987</td>
<td>B.S., M.S.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>B.S.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>B.S.</td>
<td>Presentations. Very little at SJSU. Learned it all on the job.</td>
<td>I would be interested to know how the academic planning process has evolved in the department since the 80s and what the process looks like today.</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>M.S.</td>
<td>University of Massachusetts B.S. Astronomy</td>
<td>The PLO program was not in place when I took my classes at SJSU. Just as aside, working in private industry for 6 years followed by the USGS for 33+ years was the equivalent for a nearly endless Grad school education among some of the most intelligent people I’ve ever had the privilege to associate with— Please encourage students at SJSU to somehow get such associations and the knowledge gained from such an association—they will readily benefit from it in the long run. And never, ever give up on a Field Methods class and Summer Field. Despite the current trend towards relying on computers to deal with everything, my hands-on field experience led to a huge increase in both professional papers and public outreach still in great demand, especially by those lacking a scientific background. (And tell students never to let anyone know when they retire – when they do, they will be besieged with requests to assist in all sorts of volunteer projects. In short, it’s a joke.)</td>
<td></td>
</tr>
<tr>
<td>1960(?)</td>
<td>B.A.</td>
<td>Pretty good, all-in-all.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>M.S.</td>
<td>Florida Atlantic University B.S. Geology</td>
<td>It would be very helpful to offer applied environmental and engineering geology classes for students entering the work force.</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Degree</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>B.S.</td>
<td>Outstanding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>B.A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>M.S.</td>
<td>working while going to school</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>B.S.</td>
<td>Unprepared due to change in discipline. I took post-baccalaureate courses at Foothill College to prepare.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>M.S.</td>
<td>Computational</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>B.S.</td>
<td>Average. My M.S. program was heavily applied to mining geology and SJSU does not cover that subject matter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>B.A.</td>
<td>Outstanding!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In order to be proficient and stay proficient over time, tasks involving field work require lots of practice in the field.

My education at San Jose State provided an extremely solid background in geology overall, including applied geology, and general science. It provided the basis for my subsequent graduate degree and career over the last 45+ years, which continues to this day. The faculty were outstanding (overall) and very accessible to the students. I don’t think I could have gotten a better education anywhere else. And I think I can assert this with some force, having served at other universities as both Director of Undergraduate Studies (8 years) and Department Head (10 years). I hope that the program today is as strong as it was back in my day.

The classwork provided strong a strong geologic foundation. Coursework on sampling, basic mine engineering and geostatistics are critical for a BS degree.

Preparing students for the real world applications of geology is becoming increasingly critical. I suggest investing in separate mining and oil & gas courses so that students have the background/knowledge on how geology applies to these job sectors. My experience in Canada has shown undergraduate students from Canadian universities are extremely well versed in the workings of industry geologists as their course-load emphasizes developing applicable job skills while focusing on the core principles of geology as a science. Bringing in industry professionals to give talks about their industry and career with students would provide a great tool for exposing the types of careers available to the students once they’re done with the program.

Thanks to my SJSU Geology education, I was not only well prepared for my advanced degree, but I feel it was THE major contributor to my subsequent success in my career fields.
<table>
<thead>
<tr>
<th>Year</th>
<th>Degree</th>
<th>Institution</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>M.S.</td>
<td>Cal Poly, SLO, Environmental &amp; Systematic Botany</td>
<td>My education at SJSU was the reason I got my job at the US Geological Survey in Menlo Park. I just retired after 31 years there. Thank you.</td>
</tr>
<tr>
<td>2009</td>
<td>M.S.</td>
<td>Cal Poly, San Luis Obispo, Soil Science</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>B.S.</td>
<td>When I started graduate study at the University of New Mexico it was clear I was as prepared or more prepared for graduate study as any student in the department. Outstanding - please see previous comment.</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>B.S.</td>
<td>B.A. Fine Arts; U.C.L.A.</td>
<td>Keep up the great work. Please make field-based geology a high priority, as it was when I was at SJSU.</td>
</tr>
<tr>
<td>1989</td>
<td>B.S., M.S.</td>
<td>Portland State University B.S., Earth Sciences</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>B.S.</td>
<td>Looking back, I find that soil classification (USCS) and calculating/drawing groundwater contours/gradients to be the most important skills that I have used in my environmental consulting career. Report writing skills differed a bit: writing a report that states a case for regulatory case closure seemed a bit different than the types of reports that I recall writing in the B.S. Geology program.</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>M.S.</td>
<td>un-fucking-believably awesome. SJSU remains the gold standard in my opinion for geologic education.</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>B.S.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>B.A., M.S.</td>
<td>I had a long and what I consider a productive career which I think was due in large part to the good education I received from the SJSU Geology Department that was based on a fundamental, field-based curriculum.</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Degree</td>
<td>Institution</td>
<td>Major</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>-------------</td>
<td>-------</td>
</tr>
<tr>
<td>1983</td>
<td>M.S.</td>
<td>Colby College, BA</td>
<td>Geology</td>
</tr>
<tr>
<td>1985</td>
<td>M.S.</td>
<td>Humboldt State University, B.A.</td>
<td>Geology</td>
</tr>
<tr>
<td>2002</td>
<td>B.S.</td>
<td>San Jose State University, BA 1974</td>
<td>Geophysics</td>
</tr>
<tr>
<td>2006</td>
<td>M.S.</td>
<td>Univ of Michigan</td>
<td>Geology/Anthropology</td>
</tr>
<tr>
<td>1975</td>
<td>B.A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>M.S.</td>
<td>San Jose State University</td>
<td>Geophysics</td>
</tr>
<tr>
<td>1976-79</td>
<td>M.S.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>M.S.</td>
<td>Fantastic B.S., Soil Science, Cal Poly SLO</td>
<td></td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td>BS science Teaching, Mankato State University, Mankato, MN</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>B.S.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>B.A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>B.S.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Despite the fact that my career was in Law Enforcement, primarily criminal investigation, my studies in Geology have been invaluable. Not only did the critical reasoning skills I learned aid my investigative work, but the instruction in scientific methodology helped my work in the forensic science discipline of digital forensics. While not all graduates of the program will go on to work in the field, they will find that the education they receive has much farther reaching applicability. 

Jonathan rules

The geology department at SJSU may be small, but the quality of faculty is high and that produces high quality education and graduates!

Encourage students to take the GIT in their last semester or right after graduating. I would have benefited from more information and encouragement.
<table>
<thead>
<tr>
<th>Year</th>
<th>Degree</th>
<th>School/Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>M.S.</td>
<td>University of Notre Dame, B.S. Geological Science</td>
</tr>
<tr>
<td>2003</td>
<td>M.S.</td>
<td>Very Good</td>
</tr>
<tr>
<td>2012</td>
<td>B.S.</td>
<td>question 3 only allows one answer, check all that apply</td>
</tr>
<tr>
<td>1993</td>
<td>M.S.</td>
<td>At Stanford I learned the faculty had the highest regard for the SJS program. Indeed, my SJS degree landed me a free ride toward obtaining a PhD.</td>
</tr>
<tr>
<td>1987</td>
<td>B.A.</td>
<td>The one week spring break course on thin-section making came in very handy at work. All of the “hands-on” learning was useful at work.</td>
</tr>
<tr>
<td>1979</td>
<td>B.A. M.S.</td>
<td>Teach the students how to work hard. My first boss at the USGS preferred SJSU students to Berkeley because we knew how to work hard, owned the work, and didn’t complain.</td>
</tr>
<tr>
<td>1979</td>
<td>M.S.</td>
<td>Cal State Northridge University, B.S. Geology 1971</td>
</tr>
<tr>
<td>2014</td>
<td>M.S.</td>
<td>University of the Pacific</td>
</tr>
</tbody>
</table>

Keep all the writing requirements in all MS classes. They don’t need be all giant papers. Have classes incorporate writing abstracts and other smaller writeups.
<table>
<thead>
<tr>
<th>Year</th>
<th>Degree</th>
<th>University</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>M.S.</td>
<td>California Polytechnic State University San Luis Obispo</td>
<td>Every graduating student should have several contacts from local industry professionals and possibly non-local professionals.</td>
</tr>
<tr>
<td>1983</td>
<td>M.S.</td>
<td>Ohio State University, B.S. Geology and Mineralogy</td>
<td>SJSU needs to integrate co-op, internship, and outreach in EVERY upper division geology course.</td>
</tr>
</tbody>
</table>
| 2008, 2017 | B.S., M.S. |                                                     | 1. I've ranked all of your objectives as 'highest' because I think holders of a M.S. degree should be more than proficient in all those categories. I don't expect that helps you much. Sorry.  
2. Remember, I graduated from SJSU a long time ago and the program today is vastly different from what I experienced. While Bob & Jonathan & Ryan are excellent in the field, the de-emphasis of field work has, in my opinion, devalued the SJSU program. Yes, I know people today must know new techniques, but it all has to tie back to actual, boots on the ground observation & evaluation. There's more knowledge, so it's not unreasonable to expect students to learn more. |
| 1979   | B.A., M.S. |                                                    | really good                                                                 |
| 2015   | M.S.   | East Carolina University, B.S. Geology | Perhaps offering MS courses pertaining to economic and/or petroleum geology. While I attended I do not recall faculty offering such classes. For those students interested in the above careers it would be nice to offer something at least every other year. |
| 1952   | B.A.   |                                                    |                                                                           |
| 1951   | B.S.   | I liked having to do a business presentation in engineering geology. Very helpful. | Though I answered your questions, since I never worked in Geology, I'm not sure you want to count my answers. The other thing I really benefited from was. Of |
| 1955   | B.A.   |                                                    |                                                                           |
| 1976   | B.S.   |                                                    |                                                                           |
| 2013   | B.S.   |                                                    |                                                                           |
APPENDIX 9.8

General Education Assessment Reports

Note – More reports are included than on University GE Assessment Website
General Education Annual Course Assessment Form

Course Number/Title: **Geol 001, General Geology**  GE Area **B1 (+B3; effective Fall 2012)**

Results reported for: AY 2011-2012  # of sections: 5  # of instructors: 2

Course Coordinator: Jonathan Miller  E-mail: jonathan.miller@sjsu.edu

Department Chair: Jonathan Miller  College: Science

**Instructions:** Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be **electronically submitted**, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

**Part 1**

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

**SLO#3:** Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

This SLO is assessed constantly in Geology 1 through homework, in-class group assignments, and questions on exams. Two specific examples include: (1) location of an earthquake epicenter by processing seismic data, plotting that data on a graph and triangulating to find the results using Google Earth; (2) determining the age of a rock via radioactive decay, where students learn how to compute half-lives of radioactive isotopes, and learn which isotopes are best to date various types of rocks. Approximately 85% of students can adequately describe how to determine the epicenter of an earthquake on an exam. Approximately 95% of the students correctly identified the number of half-lives that has passed for a given amount of parent isotope.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

No specific modifications are planned. However, starting in Fall 2012 this course will also include a lab component, which will provide even more exercises and activities that can be used to assess this learning objective.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?
All sections are still aligned with Area B1+B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title  Geol 001, General Geology  GE Area B1

Results reported for: AY 2012-2013  # of sections: 4  # of instructors: 2

Course Coordinator: Jonathan Miller  E-mail: jonathan.miller@sjsu.edu

Department Chair: Robert Miller  College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 1: Students can use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

The SLO was achieved through in-class discussion and activities plus assessment within graded examinations in all sections of Geology 1. A number of specific assignments are used in Geology 1 to assess this SLO. Below is one example.

Students experimented with porosity and permeability in class to evaluate how porosity and permeability might affect the transport of contaminants in the ground. Students then were asked to apply this knowledge to the issue of hydraulic fracturing (“fracking”) and evaluate arguments for whether or not fracking is dangerous to humans and the environment. Students were able to evaluate opposing attitudes on fracking based upon their knowledge of groundwater movement and were able to grasp the complexity of this issue as a mixture of science, politics, and social welfare.

Exam questions and homework assignments revealed that about 85% of the students achieved this SLO. Other geologic content used to assess this SLO and covered throughout the semester in Geology 1 include: earthquake prediction and hazards, stream behavior and flooding, and coastal geology vs. coastal development.
(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

No specific modifications are planned. Assignments are continually updated to make connections to the most current geologic events, such as major flooding, earthquakes, and new scientific discoveries. The course schedules are modified from semester to semester to cover current events that provide examples or applications of geologic concepts relevant to SLO 1.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B1 and B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title: 001 General Geology
GE Area: B1 & B3

Results reported for AY: 2013-14
# of sections: 4 lect, 9 lab
# of instructors: 2

Course Coordinator: Robert Miller
E-mail: robert.b.miller@sjsu.edu

Department Chair: R.B. Miller
College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 2: Students should be able to demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

The student learning objective was achieved through lectures and in-class discussions, as well as homework assignments and exam questions. Students examined the interaction between the earth and people and evaluated the ways in which a scientific understanding of the earth could influence societies. In studying earthquakes, volcanic eruptions, stream and coastal erosion, and climate change, students also examined the interaction between these geologic processes and societies to better understand how disasters can be avoided, at least in the sense of the loss of life and property. On exams that included questions about natural hazards and humans, 72% of students demonstrated proficiency in such topics.

Students also completed an assignment in which they watched an hour-long video that discussed water issues in California, and how the acquisition of water allowed for the development of Los Angeles and surrounding areas. Students then wrote a short response to the video in which they evaluated the positive and negative aspects of water acquisition on local and distant communities. They also formed and articulated opinions about the social responsibility associated with diverting water to areas that have very little precipitation. 85% of students demonstrated an understanding of such complex issues, as well as the ability to evaluate the moral and societal implications associated with these issues.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)
We will continue to utilize these assessment instruments. Students will also write an essay, choosing from a variety of topics, some of which will focus on geologic hazards and how they affect humans.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B1 and B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title ___001 Geology____________ GE Area __B1 & B3_________________

Results reported for AY __2014-2015_________  # of sections ___X______  # of instructors X

Course Coordinator: _____Donald Reed_______________ E-mail: __________

Department Chair: _______________________________ College: __Science___________________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 3: Recognize methods of science, in which quantitative, analytical reasoning techniques are used.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Student learning objective 3, in which students learned to recognize methods of science through quantitative and analytical techniques was achieved in Geology 001 through class lectures, class discussions, in-class assignments, quizzes, and exam questions.

One specific example of students applying quantitative and analytical techniques in the course includes the calculation of a river’s discharge. Here, students were expected to quantify a river’s discharge by learning the equation for discharge, measuring the length, width, and height of the channel form and then calculate discharge for different stream velocities. The students’ analytical skills were then applied through a series of concept tests, which portrayed different scenarios where variables in the equation for discharge change. Below are two quiz questions students were expected complete by the end of the lecture on streams that required recognition of science methods through the combination of quantitative and analytical skills.

1. A stream channel is narrowed by bridge construction. How will the velocity of flow change if the depth and discharge of the stream remain constant?
   a. velocity will increase        b. velocity will decrease      c. velocity will not change
2. What is the discharge of a stream in a rectangular channel that is 10 meters wide, 6 meters deep, 40 kilometers long, and has a velocity of flow of 5 meters per second?
   a. 21 cubic meters per second
   b. 300 cubic meters per second
   c. 1200 cubic meters per second
   d. 2400 cubic meters per second

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

One specific modification to 001 Geology includes the implementation of a math review lab for the laboratory section of the course. The math review lab will help students recognize and learn specific math skills required for the remainder of the semester.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes. No actions are planned.

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

Not applicable.
General Education Assessment Schedule

Area B1, B2, B3: SCIENCE

Course Prefix and Number: _______ Geology 1______ Course Title: _______ General Geology___________

Course Coordinator: _____ Jonathan Miller______ E-mail_________jonathan.miller@sjsu.edu__________

Submission Date: _______ 10 October 2015_________ College: _______ Science____________________

End of next Program Planning cycle (Self Study due to Dean; see Program Planning) __ Fall 2017__________

Instructions: Each GE assessment schedule must indicate the plan for assessing all SLOs during the program planning cycle (beginning with the AY of the last PP Self Study and concluding with the last full AY prior to the year in which the PP Self Study is due). Departments may assess any combinations of SLOs in a given year, but they must assess all GE area SLOs in a program review cycle. Some assessment of the course is required each academic year.

<table>
<thead>
<tr>
<th>GE Student Learning Objective</th>
<th>When will this SLO be assessed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLO 1: Students should be able to use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations</td>
<td>2015-2016</td>
</tr>
<tr>
<td>SLO 2: Students should be able to demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.</td>
<td>2016-2017</td>
</tr>
<tr>
<td>SLO 3: Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used.</td>
<td>2015-2016, 2017-2018</td>
</tr>
<tr>
<td>Other: (optional; e.g. diversity, writing)</td>
<td></td>
</tr>
</tbody>
</table>

This assessment schedule must be electronically submitted to <curriculum@sjsu.edu>, by the department chair to the Office of Undergraduate Studies with an electronic copy to the home college. Assessment schedules for all GE courses are due October 1 of the AY in which the PP Self Study is due.
General Education Annual Course Assessment Form

Course Number/Title: Geology 03, Planet Earth__________ GE Area: B1 ________________

Results reported for AY 2012-2013 # of sections 3 # of instructors 1

Course Coordinator: Robert Miller E-mail: Robert.b.miller@sjsu.edu

Department Chair: Robert Miller College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 1: Students can use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

The SLO was achieved through in-class discussion and activities, and assessed both informally and by test questions. Prior to using scientific methods, students were introduced to them and the process of scientific inquiry. For example, students made use of various data sets (plots) and reports to discuss and assess the growing concern of global climate change. A follow-up in-class activity required students to propose solutions to mitigate the harmful effects of climate change. During these activities, the instructor observed strong debates within groups, with students openly sharing constructive ideas and explanations with their peers while making use of the scientific material. This SLO was then quantitatively assessed through questioning in an examination where 80 % of students could successfully link human activity to the greenhouse effect.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

To better ascertain student understanding in this subject in the upcoming year, assessment will also include in-class and take-home graded assignments. These assignments will have more directed
questioning at an earlier stage (than only test questions) with the goal of ensuring stronger learning of the material, and for the instructor to more accurately assess student weaknesses.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B1 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title _______ GEOL 3 ___________ GE Area _________ B1 ________________

Results reported for AY ____2015-2016___ # of sections ____4_______ # of instructors ____3_______

Course Coordinator: ____Jonathan Miller____ E-mail: _______jonathan.miller@sjsu.edu________

Department Chair: _____Jonathan Miller____ College: _____________Science_________________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What GELO(s) were assessed for the course during the AY?

GELO 1: Students should be able to use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

In this course there were two assignments that required fieldtrips to identify rock types and locations of possible natural hazards. In these two assignments, students were asked to use the scientific method explained in class and propose solutions to minimize the impact of perceived natural hazards (ex. earthquakes) in a location of their choice. Students were also exposed to the limits of scientific investigation when they tentatively had to find locations of possible natural hazards.

The results were quite positive. More than 85% of students were able to go on the field and answer the questions correctly using methods of investigation. More than 86% were able to propose solutions to minimize the impact of perceived natural hazards in the locations of their choice.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

For the upcoming year, it is planned to use:

a) More in-class videos and peer-reviewed papers explaining the benefits of using the scientific method to solve earth science related problems.

b) More in-class group debates on the role of the earth science in identifying and solving potential natural hazards.
Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (GELOs), Content, Support, and Assessment? If they are not, what actions are planned?

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE GELOs for writing.
Spring 16: 99 Students total
Summer 16: 9 students

GELO 3: Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used.

During the Spring and Summer of 2016, several assignments were created to address GELO 3: “Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used”. The primary source of assessment for this GELO was a term paper that prompted students to choose a scholarly article, critically assess the article to determine if the study met all the steps of the scientific method, and explain how the research was carried out. Out of 108 students, 106 handed in their term paper, and the average score was 86%, indicating that students had a good grasp of the material they researched, while also performing fairly poorly in their ability to write a sound essay. Students were encouraged to utilize the SJSU writing Center, but it seems some of them did not heed the advice.

Another assignment where quantitative, analytical reasoning techniques were employed was one where students practice various dating methods through the use of relative dating principles via block diagrams as well as the more modern technique of calculating a true age based on isotopic ratios and mathematical formulas. This assignment was introduced during the summer of 2016 and out of the 9 students in the class, all nine completed the assignment with an average score of 90%.

Finally, another assignment introduced during the Summer of 2016 was to model stick-slip behavior of faults through the use of an apparatus in the classroom that demonstrates the process. Students were asked to predict how the apparatus would behave, and then they discussed the results of the experiment after the apparatus was used. Students also earned roughly 90% on this assignment, with the high average owing in part to the fact that they worked in groups and were allowed to brainstorm before the experiment.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 004L – Planet Earth Laboratory  
GE Area: B3

Results reported for AY: 2012-2013  
# of sections: 16  
# of instructors: 9

Course Coordinator: Ellen Metzger  
E-mail:  ellen.metzger@sjsu.edu

Department Chair: Robert Miller  
College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 1: Students can use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

This SLO was assessed by reviewing student performance and engagement for Lab 4: Climate Change? The Modern CO2 Record. This lab involves interpretation of graphs to describe short-and long-term increases in atmospheric concentrations of carbon dioxide and methane.

Student reactions to this lab exercise were discussed with the Geology 4L instructors who reported that students are interested in climate change and generally earn a B or better on this assignment, but do not exhibit a high level of engagement in this exercise. This is partly due to the fact that the most recent values given for CO2 concentrations are from the mid-2000s.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

Based on her conversations with the 4L instructors, Metzger will update this lab exercise to include more recent atmospheric data and expand it to include exploration of the current and anticipated
impacts of climate change due to rising greenhouse gas concentrations, including ocean acidification and changes in ocean circulation. New activities to complement the graph interpretation questions will include viewing of short videos and hands-on exploration of density-driven ocean circulation. These modifications are part of Metzger’s ongoing revision of the 4L lab exercises to include more examples of the interconnectedness of Earth’s atmosphere, oceans, and living things, make more connections to students’ everyday lives, and engage students in additional hands-on investigations.

Student performance on the revised lab will be assessed on the basis of average grades earned for this assignment. Discussions with the 4L instructors will be used to gain a qualitative measure of whether the revisions lead to greater student engagement.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B3 goals and student learning objectives.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 004L – Planet Earth Laboratory

GE Area: B3

Results reported for AY: 2013-2014

# of sections: 18

# of instructors: 10

Course Coordinator: Ellen Metzger

E-mail: ellen.metzger@sjsu.edu

Department Chair: Robert Miller

College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 2: Students should be able to demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

This SLO was assessed by reviewing Lab 4: Climate Change, in which students interpret graphs showing short- and long-term increases in atmospheric concentrations of carbon dioxide and methane. Geology 4L lab instructors reported that although students often express an interest in climate change and generally earn a B or better on this lab, they typically do not exhibit a high level of engagement in this exercise. This may be due in part to the fact the exercise does not make explicit connections with the environmental, social and economic impacts of human-caused climate change and does not relate the problem of rising greenhouse gas emissions to students’ everyday activities.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Based on extensive discussion with the 4L lab instructors, this lab exercise was revised and expanded to include 1) a hands-on activity in which students perform a serial dilution of food coloring in water to investigate the concept of parts per million and relate it to atmospheric concentrations of CO2 and 2) an investigation of sea level rise due to melting glaciers.

In an accompanying Web-based assignment, students further investigate the impacts of climate change and calculate their personal ecological footprint. They are then asked to reflect upon what actions they could take to reduce it their individual footprint.

These modifications are part of Metzger’s ongoing revision of the 4L lab exercises to include more examples of the interconnectedness of Earth’s atmosphere, oceans, and living things, make more
connections to students’ everyday lives, and engage students in more hands-on investigations. Student performance on the revised lab will be assessed on the basis of average grades earned for this assignment. Discussions with the 4L instructors will be used to gain a qualitative measure of whether the revisions led to greater student engagement.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 004L – Planet Earth Laboratory
GE Area: B3

Results reported for AY: 2014-2015 # of sections: 14 # of instructors: 8

Course Coordinator: Ellen Metzger E-mail: ellen.metzger@sjsu.edu
Department Chair: Jonathan Miller College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO #3: Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Since the last assessment of SLO3 for Geology 4L, several labs have been revised to include more quantitative analysis. This report focuses on modifications to Lab 3: “Atmospheric CO₂ Levels, Climate Change and Sea Level Rise.” The following activities have been added to this exercise: 1) serial dilutions of food coloring to illustrate parts per million, the unit of measurement for atmospheric concentrations of CO₂ and 2) calculation of the magnitude of sea level rise that would result from melting of the Greenland ice sheet. A related post-lab web assignment asks students to measure their ecological footprint using an online calculator and to interpret graphs which show what percentages of their footprint are associated with food choices, shelter, transportation, etc.

Metzger interviewed a subset of Geology 4L instructors (all of whom are graduates students in the Department of Geology) to assess the degree to which students are able to successfully complete these exercises. Instructors estimated that about 75% of their students earned a “B” or better on Lab 3, but some students required assistance with the calculations.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

Geology 4L labs typically enroll students with a wide range of quantitative and analytical capabilities and some struggle with fundamental skills such as percentages, decimals and conversion of units. Metzger will work with the 4L lab instructors to develop worked examples of calculations needed for Lab 3 (and other 4L labs) that will be presented before students begin the lab.
Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B3 goals and student learning objectives. No action is planned.

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

Not applicable.
General Education Annual Course Assessment Form

Course Number/Title: Geology 006, California Geology  
GE Area: B1

Results reported for AY 2010-2011  
# of sections 2  
# of instructors 1

Course Coordinator: Emmanuel Gabet  
E-mail: manny.gabet@sjsu.edu

Department Chair: Robert Miller  
College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO #2: Students can demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

The concept of the 100-year flood underpins financially and socially relevant decisions regarding flood hazards, insurance premiums, and zoning laws yet, in the absence of centuries-long datasets, it is a statistical construct with no real meaning. As a class exercise, students create a flood-frequency curve with discharge data from a creek in the San Francisco Bay Area. Because the data set (like most in the U.S.) is too short, the instructor shows the students how to use their flood frequency curve to extrapolate the discharge for the 100-yr flood. The students are then asked to give a discharge value for the 1-year flood. Extrapolation of “noisy data” is inherently imprecise, and there are a wide range of answers. The instructor then emphasizes that there is no right answer because, until we have 100 year’s worth of data, we have no idea what the 100-yr flood is. This leads to a discussion of the difficulties of predicting and preparing for natural hazards and the responsibilities of those living in geologically dangerous environments.

The students turn in their flood frequency curves and that is graded. Most of the students (~80%) manage to do this correctly with minimal help from the instructor in making several mathematical operations that need to be done to transform the raw data. Only a handful of students participate in the discussion, but most of the others seem attentive.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)
No modifications are planned.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned? Yes, all sections of Geology 006 still meet the GE requirements for Area B1.
General Education Annual Course Assessment Form

Course Number/Title: Geology 06, Geology of California  GE Area: B1

Results reported for AY: 2012-2013  # of sections: 3  # of instructors: 2

Course Coordinator: Robert Miller  E-mail: robert.b.miller@sjsu.edu

Department Chair: Robert Miller  College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 1: Students should be able to use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Students evaluated the evidence for uniformitarianism (“present is key to the past” and vice versa) and plate tectonics using the geologic history of California as a case study. Students were introduced to these concepts through lectures, movies, and class and group exercises. For example, the concept of plate tectonics was specifically applied to both California’s current tectonic setting and the rock patterns that reflect ancient tectonic settings. The student learning was assessed through exam questions and a term paper. From the exam questions, about 80% of the class achieved satisfactorily the SLO, whereas on the basis of the term paper, approximately 85% of the students mastered the SLO. The term paper was a particularly affective exercise in that it permitted students to understand how these concepts affect them as individuals (e.g., proximity to plate boundaries and seismic hazards, plate boundaries and mineral resources, etc.)

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

The instructor will continue to enhance class exercises and information. For example, informal periodic assessments will be done of student understanding of concepts before the term paper is due.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):
(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B1 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title _Geol 6/California Geology_____ GE Area __B1_________________________

Results reported for AY ______2014/15 # of sections _____2____ # of instructors _____2____

Course Coordinator: ______Manny Gabet____________ E-mail: manny.gabet@sjsu.edu

Department Chair: __Jonathan Miller____________________College: _Science____________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 3: Apply a scientific approach to answer questions about the earth and environment.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

This SLO was assessed in GEOL 6 using targeted in class hands-on activities and assignments and follow-up quiz and exam questions. Based on aggregated data from these assessment tools, 80% of students (N=71) demonstrated mastery of the SLO.

An example of one of the assessment activities from Instructor LeAnne Teruya: We did an experiment in class to illustrate why it is difficult to predict volcanic eruptions in the long term. The class was broken up into six groups and each group completed the same experiment. Then we pooled and compared the results to produce a large aggregate sampling of repeat experiments. The experiment simulated volcanic eruptions by having students add weights to the pull-string of a party popper that was attached to a stand. Students recorded the amount of weight required to cause the an “eruption” (the popper to pop). The results varied because the construction of each popper varies slightly, even though they are all manufactured by the same company and using the same process. Because the amount of weight required to “erupt” the popper varies, it is not possible to predict the amount of weight that will cause eruption. Students were shown other data from repetitions of the same experiment, which showed that even after 25 trials, there is no pattern that can be used to predict the weight that will cause eruption of the popper. Likewise, even though volcanoes within a specific category may all be alike, each volcano varies randomly in its construction and therefore the specific variables that trigger an eruption for a particular volcano are difficult to predict. The SLO was then assessed using a follow-up exam question about the ability to make long-term eruption predictions for volcanoes.
(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

No major modifications to the course are planned

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes. No actions are planned.

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

Not applicable.
General Education Annual Course Assessment Form

Course Number/Title __Geol 006 California Geology__  GE Area _________________________________

Results reported for AY __2015-2016_______  # of sections ____1______  # of instructors ____1_____

Course Coordinator: ______________________________ E-mail: _________________________________

Department Chair: _______________________________ College: _____Science_______________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to curriculum@sjsu.edu, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What GELO(s) were assessed for the course during the AY?

GELO #2  Students can demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

The study of earthquakes encompasses the examination of both science and society, and the interrelation of the two. Students learn about the causes and effects of earthquakes and how society reacts to scientific data about earthquakes. To illustrate connection between the scientific and social aspects of earthquakes, students were taken on two fieldtrips. The first was a fieldtrip around the exterior of Duncan Hall to examine how Duncan Hall has been retrofitted to better withstand earthquakes. Prior to the fieldtrip, students learned what soft-story buildings are and why they are very unsafe during earthquakes. During the fieldtrip, students drew in on a map, the locations of shear walls that were added to the ground floor of Duncan Hall to improve stability during an earthquake. The second fieldtrip was to the town of Hollister where the Calaveras Fault actively creeps through a portion of the city. Students learned to identify evidence of fault creep in sidewalks, roads, and buildings. As the students mapped the Calaveras fault, they could see how the fault cuts right through residents’ properties and houses. This always leads nicely into a discussion about whether the residents are aware of the fault, why people would choose to live on or very near to a fault, and what happens if you do find yourself living on or near a fault. Back in the classroom, we discuss the governments’ role in informing people about the presence of faults, and preventing new construction on faults (i.e. the Alquist-Priolo Act). We discuss why people are allowed to live on and very near to active faults and whether current laws are adequate to protect people. We also discuss how much can be legislated given the current scientific data on earthquakes.

From the Duncan Hall fieldtrip, students learn that damage from earthquakes can be mitigated by better building practices: better building design, seismic building codes, and addition of shear
walls. Students learn that scientific data from earthquakes has resulted in better seismic building
codes and that the results have saved people from injuries, death, and property loss. 75% of the
students were able to draw in all the shear walls added to Duncan Hall, without any help. Most
of the remaining students could identify the walls, but needed help drawing the walls on the map
of Duncan Hall. From the Hollister fieldtrip, students learn that even tiny movement along a
fault if constant, can cause a great deal of damage. Students see how this has affected residents
who live on or near the Calaveras fault, learn about the reach and effectiveness of current laws.
85% of the students correctly identified evidence of fault creep and correctly drew in the trace of
the Calaveras fault on the map of the fieldtrip area.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the
upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

A service learning project is being planned wherein students will prepare an earthquake information
sheet that will provide pertinent information for students living in on campus housing on what to do
in case of an earthquake in San Jose. These information sheets will be distributed to all dorm
students at the beginning of the school year. Students will also design and promote dorm-friendly
earthquake kits.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (GELOs),
Content, Support, and Assessment? If they are not, what actions are planned?

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z),
please indicate how oral presentations will be evaluated with larger sections (Area A1), or how
practice and revisions in writing will be addressed with larger sections, particularly how students
are receiving thorough feedback on the writing which accounts for the minimum word count in this
GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and
Z), documentation that the students are meeting the GE GELOs for writing.
**Course Number/Title** Geology 7, Earth, Time, and Life  
**GE Areas** B1 + B3

**Results reported for** AY 2012/2013  
**# of sections** 4  
**# of instructors** 2 (One in F’12, two in S’13)

**Course Coordinator:** Jonathan Hendricks  
**E-mail:** jonathan.hendricks@sjsu.edu

**Department Chair:** Robert Miller  
**College:** Science

**Instructions:** Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be **electronically submitted**, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

**Part 1**

**To be completed by the course coordinator:**

1. **What SLO(s) were assessed for the course during the AY?**

   SLO 1: Students can use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

2. **What were the results of the assessment of this course? What were the lessons learned from the assessment?**

   Geology 7 (Earth, Time, and Life) explores in-depth the discovery-based development of three scientific ideas that broadly address SLO 1: plate tectonics and the antiquity of the earth (physical science) and evolution (biological science). Students received substantial instruction (1-2 lectures in all sections) on how the discovery of plate tectonics revolutionized preexisting explanations for major features of the earth, including mountains, volcanoes, ocean basins, and earthquake distributions. They also learned substantial information (2-3 lectures in all sections) about how scientists discovered the antiquity of the earth (4.6 billion years old, rather than 6,000 years). Additionally, students received 1-3 lectures of instruction in each section on the development of evolutionary theory for explaining the diversity of modern and ancient life forms, as opposed to a non-scientific, creationist perspective. These three discoveries revolutionized our understanding of earth history, which is the subject of Geology 7, and are interwoven throughout the entire course. Broadly speaking, we feel we have been successful in conferring this information because 91% of the 193 students who completed Geology 7 in AY 2012/2013 (4 total sections; instructors J. Hendricks [3 sections] and N. Shostak [1 section]) received a final grade of C- (70%) or higher.

   Prof. Hendricks directly assessed this SLO using a 1100 word writing assignment. Students were asked in F’12 to use scientific evidence to debunk a creationist argument that the rock and fossil record are only several thousand years old and are a result of “Noah’s flood”. 70% of the 81 students (two sections) who completed this assignment received a final grade of 70% or higher. In S’13, students were required to debunk two creationist claims in their writing assignment (1500 words). 92% of the 37 students who completed the final draft of this assignment received a final grade of 70% or higher.
Ms. Shostak addressed this SLO in her section using a homework assignment. After a series of lectures and a computer lab exercise explaining the scientific method and the theory of plate tectonics, students were asked to determine for themselves whether plate tectonics is at work today in California. Students were given a homework assignment that required them to use live location data from GPS stations to discover whether, how fast, and in what direction different areas within California may be moving. Students were asked to calculate total station movement and average station velocity over the period for which data were given (approximately 10 years, depending on station), with the most recent data collected a day or two before the due date of the homework. Students worked first individually and then in groups of 3 or 4 on each station, then the class compiled a map of station velocities, overlaying a Google Earth map of California with students’ station velocity vectors to see the big picture of plate movement in California. Students scored an average of 58 out of 66 points on this exercise (88%), with 65 of 73 students scoring a grade of 70% or better.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

Prof. Hendricks is confident of the quality of instruction in Geology 7 with respect to instructional coverage of SLO 1 (as well as the other Area B1 + B3 SLO’s), but the assessment of student learning in this course should be improved. This is especially true now that multiple instructors are teaching the class. Hendricks will remedy this by developing multiple targeted quiz/exam questions, activities, and/or writing assignments that will specifically address each of the SLO’s. Students will also be given the opportunity at the end of the semester to reflect on whether or not they thought the SLO’s were satisfied by the course instruction and activities. These questions and activities will be uniformly administered across all sections of Geology 7, regardless of instructor (every Geology 7 instructor will receive a copy of specific SLO assessment questions/activities at the start of the semester so that these can be best integrated into their classes). This change will begin this semester (Fall 2013). The results of the change will be discussed in the analysis on next year’s GE Assessment for Geology 7. Explicit discussion will also be reported on how instruction will be adjusted in areas where results of assessment suggest need for improvement.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B1 and B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title: Geol 07, Earth, Time, and Life  
GE Area: B1 and B3

Results reported for AY 2013-14  
# of sections 4 (11 lab sects)  
# of instructors 3

Course Coordinator: Robert Miller (Jonathan Hendricks on sabbatical)  
E-mail: robert.b.miller@sjsu.edu

Department Chair: Robert Miller  
College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 2: Students should be able to demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

As reported in the 2010-2011 GE assessment, we maintained our focus on demonstrating the notion: the present is the key to the past. One of the many concepts taught in this class during 2013-2014 is that geological processes are largely slow and progressive, yet punctuated by catastrophic events large enough to profoundly change the biological and evolutionary landscape. The past, in this case, is even today a very contentious subject. Ubiquitous dogmatic notions, such as a 6,000-year-old Earth and the denial of evolution by a significant portion of this country, is a critical issue facing science and society today. In this class, instructors present observations and data, utilizing the scientific method, which are consistent indicators of a deep and protracted geological and evolutionary history. In short, the interplay of science and society is one of the primary foci of this class, and is addressed in multiple ways.

Students learn about climate change and how it influences, and is influenced by, complex societies. More specifically, students explore ice core data and other geological, oceanographic, and paleontological proxies that help us determine the climate patterns of the past. By focusing much attention on the interplay between climate change and the resultant environmental stressors, students can think more critically about how climate has influenced evolution, but also what lies ahead for humanity. From this, they can make better decisions concerning their personal role in mitigating these effects as much as possible.

Assessment came in many forms. Students were given the task of analyzing geological cross-sections for evidence of whether the strata indicate a rising or falling sea level. This, along with the knowledge of depositional settings for particular sedimentary rock types gained during the course, was used to help decipher climate patterns of the past. Assessment was conducted through a series of multiple-choice questions on the two
mid-term exams. On the basis of the answers, the percentage of students deemed successful in demonstrating understanding of the learning objective was about 75% during 2010-2011, whereas 2013-2014 saw an increase to 83%. The addition of new sets of slides and visual aids is inferred to have helped increase the percentage of students with correct answers concerning these topics on mid-term exams. In addition, an essay addressed SLO #2 in a more direct way. The term paper consisted of two prompts, and students were required to answer both: The first was to describe one of the lines of evidence that supports evolutionary theory. The second prompt more directly addressed SLO #2, as it asked students to analyze a recent PEW research poll that showed that progressively more Republicans are denying evolution, while the percentage of Democrats denying evolution has remained more or less stable, and much lower, than that of Republicans. Students were asked to explain these data. Roughly 87% of students scored a C or better on their essay; the 13% that did not score high enough also includes students who failed to hand in any essay at all.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

The updates to the class (both lecture and lab) brought forth by the regular course coordinator, Dr. Jonathan Hendricks (on sabbatical in Fall 2014), and several lab instructors under his supervision were very successful over the past three years. A different instructor, Joe Petsche, took over the lecture portion of Geology 7 in Spring 2014 and Fall 2014. Petsche has taught the laboratory component of Geology 7 in the past, and he has recently authored a college-level textbook entitled *Prehistoric Life*. The research involved in authoring this book has helped to improve the curriculum with new and updated knowledge. In addition, a new library of figures and specimens from Petsche’s personal collection has given Geology 7 additional resources for students. Petsche will continue to teach the course and we foresee no major modifications.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B1 and B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title _Geol 07_Earth, Time and Life__________ GE Area _ B1, B3__________

Results reported for AY 2014-15 # of sections 5 (lecture), 13 (lab)___ # of instructors _8__________

Course Coordinator: _Robert Miller_____________ E-mail: _robert.b.miller@sjsu.edu__________

Department Chair: _Jonathan Miller_____________ College: _Science_____________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

Use the methods of science, in which quantitative, analytical reasoning techniques are used.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Questions assessing student success in this SLO were given during the first and second mid-terms for the five lecture sections of Geology 7 during Fall 2014 (2 sections) and Spring 2015 (3 sections). Three major topics directly addressed these SLOs, each involving a set of questions on the midterm exams. Collectively, the results for these question sets are as follows: 1) Students use isotopic data to determine the absolute ages of rock samples. Two questions were given that required students to solve the problems using mental math (calculators were not allowed). The average score on these two questions for all five sections was 96%, showing that students had a very good grasp of the mathematical techniques utilized in determining ages of rocks. 2) Students used laws of relative dating to determine sequences of events that led to geological structures illustrated in diagrams. There were four different diagrams that students had to decipher the geological history. The average score on these four questions was 83%. This score can be increased at least a small amount if more time is spent going over examples of these diagrams in class and in the lab. The score reflects a general lack of spatial reasoning and three-dimensional thought among many students. 3) Students decipher block diagrams of faults and folds to determine the types of stresses that caused them as well as the sense of motion and tectonic implications of the structures. Seven questions addressed this topic, and the average score for this question set was 88%, a good score given the difficulty of some of the diagrams.

In the Spring 2015 laboratory sections (n=8) of Geology 7, SLO 3 was assessed using two problems:
Problem 1 (Lab 2, Station 3): “At this station, you need to calculate the density of the piece of granite (A) and the piece of gabbro (B) in grams/cm$^3$. Your TA will provide you with mass of the specimen, as well as some basic unit conversion values. Use the provided rulers and beaker of water to measure the volumes of each specimen. Then, calculate the density of each. Show all of your calculations and be sure to include UNITS!!! Note to students: this problem relates to Geology 7 GE Learning Objective 3.” Out of the 169 students who completed this problem, 128 (76%) students received full credit and an additional 33 students earned at least 2 of 3 possible points.

Problem 4 (Lab 4, Station 4): “Absolute age dating has to do with estimation of the actual ages of rock samples in years before the present date. Calculate the absolute age dates of the two samples below. You are provided with the following information: 1) the percentage of parent material remaining in the sample; 2) the half-life of the material under consideration; and 3) the chart to the right, which shows the exponential relationship between the amount of parent material remaining in a sample and the number of half-lives that have passed. Show your work (2.5 pts each; 5 pts total).” Assessment data related to this problem are available for 120 students (data were not provided to the instructor from one of the teaching assistants who graded the student work). Of these 120 students, 75 (63%) received full credit and an additional 32 students earned at least 4 of 5 possible points. A general lesson learned was that some lower division GE students continue to struggle with basic mathematical problem solving.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

In Fall 2015, the relatively low scores on understanding of relative dating will be addressed by spending more time in lecture going over examples of diagrams illustrating different sequences of events. In the lab, the shortcomings illustrated by Problem 4 will be addressed by reminding teaching assistants for the lab sections to tell students to work carefully through their calculations, stress the importance of showing their work, and maintaining correct units as they solve analytical problems.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

No actions are planned

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

Not applicable.
1. During the 2015/2016 academic year, students in Geology 7 were tasked with answering questions that addressed SLO #1: Students can use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations. The SLO was addressed in a written assignment as well as several targeted questions on their exams.

2. The inquiry-based written assignment prompted students to explore the evolutionary history of a complex organism of their choosing. By doing so, creationist beliefs, which state that organisms have always been in the same form as they appear today, were brought into question. Students challenged this notion by studying the fossil record and exploring how the environment an organism finds itself in can greatly influence the set of traits it develops. While students gained an appreciation for evolutionary theory, they also assessed the scientific validity of the scholarly articles they sourced their material from. Out of 315 Geology 7 students during the 2015/2016 academic year, 311 students completed the essay with an average score of 84%. Students did an excellent job citing evidence of evolutionary adaptations, but could have done better choosing appropriate scholarly articles.

Another way SLO #1 was addressed was through several targeted questions on the midterms and final exam. One set of questions asked students to explore absolute dating as a means of questioning the claim by Young Earth Theorists that the Earth is only 6,000 years old. Students calculated the age of a hypothetical geological sample by determining the number of half lives that have passed, as well as the half-life length of a particular isotope. All 315 students took the exams. While 96% of students knew how to determine the number of half-lives that had elapsed, about 86% of students could do the final calculations to determine the sample’s age. As this calculation involved the simple multiplication of two numbers, student’s relatively low scores likely reflected the poor education they received in mathematics prior to entering college. Another question asked students to compare Alfred Wegener’s Continental Drift Hypothesis to the more modern Plate Tectonics Theory. The purpose of this question is to assess whether the student’s recognized the limitations of the original hypothesis as well as the differences between it and modern theory. Students scored an average of 93% on this question, indicating a good understanding of the subject matter. Finally, students explored two competing theories explaining when and where Homo Sapiens evolved from Homo Erectus. In particular, they were tested on their knowledge of the different lines of evidence that support each competing theory. Students scored an average of 85% on these questions, indicating that perhaps the two theories could be explained a little further in class.

3. Changes from the previous assessment of SLO #1 (AY 2012/2013) included the implementation of targeted exam questions that helped better quantify student success in Geology 7. We feel that while these questions worked well, slightly
different questions could be developed this year so that the exam questions are not identical from semester to semester. Thus, SLO #1 will be addressed through a new set of exam questions. The writing assignment will be different this year as well, and will include the opportunity for students to demonstrate their mastery of this SLO.
General Education Annual Course Assessment Form

Course Number/Title: Geol 103; Earth & the Environment      GE Area: __R___________________________

Results reported for AY: 2012-13  # of sections: 8  # of instructors: 3

Course Coordinator: Paula Messina  E-mail: paula.messina@sjsu.edu

Department Chair: Robert Miller  College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

1. What SLO(s) were assessed for the course during the AY?

   SLO 1: Students can demonstrate an understanding of the methods and limits of scientific investigation.

2. What were the results of the assessment of this course? What were the lessons learned from the assessment?

   a) Students were 92% successful in describing methods used in scientific investigations.
   b) Students were 80% successful in relating limitations of scientific investigation.

   The aggregated results were gleaned from instructors’ test items, written work, Webquests, and collaborative student presentations. For bullet point “a,” students were charged with examining changing views of our planet based on satellite coverage, Space Shuttle images, and sophisticated computers that allow increasingly more complicated models of global processes. For “b,” Students were asked to describe how the evolution of plate tectonics theory reflects testing and rejecting of hypotheses and revising of hypotheses in response to the acquisition of new data.

   All instructors’ data show that students were well-versed in identifying components of the scientific method (i.e., observation/measurement; formulating and testing a hypothesis; devising a rational conclusion, etc.), but were less able to explain iterative nature of science. We collectively agreed that students need more practice in conducting their own (individual or small group) inquiry-based assignments. With application, we believe that students will master the concept that science is not a one-way process that always leads to a definitive conclusion. Since Geology 103 is required by multiple subject teaching credential programs, we hope that future sections will allow for more modeling/application of scientific investigations by the students: especially since our prospective teachers will need to teach science more as a process, rather than a series of facts, as we transition from the California State Science Standards to the Next Generation Science Standards. Keeping Geol 103 class sizes low is one way to achieve this goal.

3. What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

   Internet resources allow for enhanced student research opportunities, and so on the short term,
we will include more Web-based assignments for students to conduct their own scientific investigations. These could be accomplished on students’ own time, which will alleviate some of the burden to conduct such activities in class. In the future, capping the enrollment of Geology 103 would greatly increase the prospects for hands-on activities, which can be discussed in real-time. We believe that instructor input would be a very helpful formative assessment technique toward this end.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?
SLO 2: Students will be able to distinguish science from pseudo-science.

(2) What were the results of the assessment of this course?

The aggregated data demonstrate that 92% (range = 82%-100%) of students who completed Geology 103 could discern between science and pseudo-science.

What were the lessons learned from the assessment?
Although only qualitative data were reported by instructors of this course, there was consensus among them that students generally arrive with little understanding of why, for example, astrology is considered a pseudo-science, while astronomy is a science. Instructors reported that, by the end of the semester, students found it easier to identify evidence, and found it easier to use evidence when drawing logical conclusions about a phenomenon, an event, or even (in the case of astrology vs. astronomy) a “field of study.” Therefore, instructors learned that explicitly identifying evidence (in data collection, experimentation, or even in argumentation) was helpful toward that end.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)
The results from 2013-2014 are encouraging. Instructors plan to continue to elaborate on elements of the scientific process when introducing students to geosciences topics, particularly those in which multiple lines of evidence culminated in an overwhelming, scientifically-accepted conclusion.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):
(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title ________ Geol 103 ________ GE Area _____ Area R _________________

Results reported for AY 2014-2015 ___ # of sections ___1___ # of instructors ____1__________

Course Coordinator: ___Paula Messina_________ E-mail: paula.messina@sjsu.edu_________

Department Chair: ___Jonathan Miller_______ College: __Science_____________________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

GELO 3: Students will be able to apply a scientific approach to answer questions about the earth and environment.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Assessments of this SLO were conducted via graded student work via a number of targeted assignments:

• Reading Air Pressure Maps: Using real time data, students learned to read and interpret air pressure maps. Students identified the gradients on the map, then interpreted, areas of high winds, light winds, anticyclonic and cyclonic winds. Students were able to connect air pressure, wind, and resulting weather. Based on graded student work, it is estimated that 75% of the students mastered these concepts and practices.

• Weathering Processes: Simulating hyper weathering conditions in the lab, students conducted an experiment on spheroidal weathering using water and sugar cubes. Students applied the scientific method, by conducting three trials, recording their observations, then analyzing the causes of spheroidal weathering. Students analyzed the effects of irregularities in the sugar cubes on the rate of weathering and pattern of disintegration of the cube structure. After the activity, students were able to properly connect the relationship between surface area and rates of weathering. They were also capable of identifying landscape features (shown in several photographic slides) that likely formed by spheroidal weathering processes. On a written test 88% of students were able to demonstrate competency in identifying real-Earth-based landforms that resulted from the process they modeled themselves.
What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

In future course offerings, there will be greater emphasis on the uncertainty of many scientific “facts.” And while some “facts” can be well understood and modeled (e.g., the processes and results of weathering), others – particularly those that exist on very small or large physical and/or temporal scales (e.g., plate tectonics, climate change, evolution, meteor impacts, etc.) are more difficult to studied.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(3) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes. No actions are planned.

(4) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

All sections taught are below the enrollment limit for Area R courses and students receive ample feedback on writing from multiple writing assignments. On each assignment, instructors provide detailed editorial and grammatical corrections, as well as general comments related to a grading rubric provided to each student.
Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be **electronically submitted**, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

1. What SLO(s) were assessed for the course during the AY?

   SLO #1 - Students can demonstrate an understanding of the methods and limits of scientific investigation.

2. What were the results of the assessment of this course? What were the lessons learned from the assessment?

   This assessment is based on a quiz in which students were asked to identify the characteristics of four common scientific methodologies used in marine fish stock assessment: population modeling, empirical sampling, correlative statistical analysis of cause and effect, and use of chaos theory. Using the material covered in an online assignment, the required reading assignments, and the instructor’s from the quiz, students then composed a 3-4 page-long essay describing the strengths and limitations of each methodology.

   Content scores of a “C” or higher (>71.5% of the possible points) on the essay, based on a well-defined grading rubric, indicate individual achievement of this learning outcome. Approximately 91% of the students (95 out of 104) who completed the course achieved this outcome. The work of students who did not meet the achievement threshold suffered from one or more of the following:

   - assignment was turned in late, thus incurring a penalty,
   - did not follow detailed assignment instructions,
   - below average reading comprehension of popular, indeed award-winning, articles written for the layperson,
   - below average writing skills, and thus could not effectively communicate the level of their learning;
   - inadequate time allocated on this assignment
(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

No modifications are planned as this time

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title GEOL 105 GE Area R

Results reported for AY 2013-2014 # of sections 3 # of instructors 1

Course Coordinator: Donald Reed E-mail: dreed@sjsu.edu

Department Chair: Robert Miller College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 2: Students will be able to distinguish science from pseudo-science.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Following an online exercise on learning outcome #2, students searched YouTube to identify examples of ocean science and pseudoscience involving the oceans. They then described these examples in terms of the identifying characteristics of science and pseudoscience in a 300-350 word-long essay.

100 out of 104 enrolled students passed the class, 99 of which achieved learning outcome #2, by earning 70% or higher on the content portion of the essay assignment, for an outcome #2 achievement rate of 99%.

One student did not submit the essay assignment that was used to assess learning outcome #2 and therefore did not achieve the learning outcome.

Students performed very well on this essay assignment in which they identified and described the characteristics of science and pseudoscience, and identified at least one example of each pertaining to the oceans.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

No changes planned for future.
Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 105 General Oceanography        GE Area: R Earth & Environment

Results reported for AY _2014-2015_____   # of sections ___2_______   # of instructors ___1_______

Course Coordinator: __Donald Reed_______________ E-mail: ___dreed@sjsu.edu________________

Department Chair: __Jonathan Miller______________ College: ______Science______________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO #3 – students are able to apply a scientific approach to answer questions about the earth and environment

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Over the last two weeks of the class, each student compiles and shares with their learning group, the top ten scientific questions they would study, if they were a professional research oceanographer. Students then have access to 70-80 scientific topics within their group, one of which will be refined by each student into a precise, and testable hypothesis or scientific question to study. Feedback is given to each student after submitting each of these assignments, both by the instructor and a member of their learning group. Each student is then taken through the process of designing a realistic scientific study to address their chosen hypothesis or question, according to the guidelines of a “request for proposals” in the final exam instructions. Each student then submits a 100 word-long abstract outlining the question to be addressed, the scientific background, the proposed research project, and the significance of the proposed work, which is then reviewed by the instructor and another student in their learning group. Students then use this feedback to write a 900-1000 word-long research grant proposal describing their project, which is then submitted online to the “Don Reed Trust for Ocean Science” at the “take home” final exam.

By undertaking this assignment, students participate in one of the cornerstones of scientific investigation by first identifying a topic to study, formulating what is not known about the topic into a precise, and testable, scientific question or hypothesis to study, and then designing a research project that, if carried to its conclusion, has the potential to provide a valid test of the hypothesis by acquiring verifiable evidence through experimentation or a field-based project.
Students do very well on this project as 65 of the 68 students, or 96% of the students who submitted the final exam achieved a “C” or better grade and therefore achieved the learning outcome. Three students did not achieve the outcome, either because their work did not present original research or contained significant errors in scientific understanding. Two other students did not submit the final exam.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

This has been a highly successful assignment in this class over a period of more than 20 years. Many students say that it is their favorite part of the course because they can apply what they learned through the entire semester in a novel and creative manner, while still maintaining the standard of high quality science. A recent change in the “request for proposals” is that proposed projects that must address some aspect of the ocean and climate change.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes. No actions are planned.

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

All sections taught are below the enrollment limit for Area R courses and students receive ample feedback on writing from multiple writing assignments. On each assignment, instructors provide detailed editorial and grammatical corrections, as well as general comments related to a grading rubric provided to each student.
General Education Annual Course Assessment Form

Course Number/Title: 107, Prehistoric Life
GE Area: R

Results reported for AY 2013-14 # of sections: 6 # of instructors: 1

Course Coordinator: Robert Miller (Jonathan Hendricks on sabbatical) E-mail: Robert.b.miller@sjsu.edu

Department Chair: Robert Miller College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?
SLO 2: Students will be able to distinguish science from pseudo-science.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?
Since this SLO was last formally evaluated in 2011, we have modified the essay used for this objective and added a quiz designed to specifically address science and pseudoscience, and better resolve student success.

In 2013-2014, students wrote two, 2.5-page essays for the class. For one essay, students chose a scholarly article and both summarized the article in their own words and critically evaluated the validity of their sources of information. The instructor gauged whether students knew the difference between science and pseudoscience, and could identify primary sources of scientific information, by the articles they chose. Depending on the section, approximately 90-94% of students found articles that were truly scholarly (i.e., from scientific journals).

A more direct approach to quantifying student knowledge of the difference between science and pseudoscience was the implementation of a quiz that directly addressed this SLO. The questions were individually tallied for the best detail concerning the data (see table below):

<table>
<thead>
<tr>
<th>Question Title</th>
<th>Total</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Of the following, which would be the best source of direct scientific information?</td>
<td>241</td>
<td>0.83</td>
</tr>
<tr>
<td>The scientific method consists of several steps, which includes the formation of a hypothesis, which means...</td>
<td>241</td>
<td>0.94</td>
</tr>
<tr>
<td>A theory is well-defined, and describes one possibility of how or why something occurs. (T/F)</td>
<td>241</td>
<td>0.90</td>
</tr>
<tr>
<td>Which of the following is NOT pseudoscience?</td>
<td>241</td>
<td>0.75</td>
</tr>
<tr>
<td>Which of the following is NOT indicative of Pseudoscience?</td>
<td>241</td>
<td>0.92</td>
</tr>
</tbody>
</table>
(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

In light of the quiz results, it appears the students could use a more expanded lecture about the wide spectrum of pseudoscience they encounter on a regular basis (see results for question 4). Otherwise, the results indicate a good overall understanding of the SLO during 2013-2014 and no major changes are planned in the near future.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title ___Geology 107 Prehistoric Life____  GE Area ____________ R ______________

Results reported for AY ___14-15______  # of sections ____8 _____ # of instructors ____4_____

Course Coordinator: ______J. Miller________________________ E-mail: ___jonathan.miller@sjsu.edu___

Department Chair: ____Jonathan Miller_______  College: ________Science________________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

GELO 3: Apply a scientific approach to answer questions about the Earth and environment

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

GELO 3 is woven throughout the entirety of Geol. 107 Prehistoric Life, as the course is about the evolution of life forms, including in response to environmental changes over geological time scales. In each section of the class in Fall 2014 and Spring 2015, GELO 3 was directly assessed using numerous targeted quiz and exam questions, in class hands-on activities, and in class and take-home writing assignments.

Of 305 total students assessed, 283 demonstrated proficiency at GELO3 by achieving passing grades (typically 80% or better) when aggregating data for all assignments and instructors.

A common problem with essay-based assignments, both in exam questions and in papers, is writing quality, and all Geology 107 instructors are tough graders in this respect—typically passing rates for writing assignments are lower than for multiple choice exam questions and in class activities used to assess GELO 3. However, instructors for 107 documented that writing quality on average improved during the course of each semester. This may be because students preferred the later assignments, or it could be because they focused more on the quality of their writing to improve their performance in the class.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

In future semesters, we intend to continue to emphasize the importance of writing quality and clarity as key to students demonstrating their comprehension and mastery of course learning outcomes. One approach that is being tried in some sections will be to give smaller and more frequent writing assignments to meet the writing requirement for the class. The idea here is to
assess whether more numerous and direct feedback will increase writing proficiency and promote greater student success in applying scientific approaches to answering questions about Earth.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes for all sections

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

All sections taught are below the enrollment limit for Area R courses, and students receive ample feedback on writing by a combination of essay questions on quizzes and exams and take-home writing assignments, which in total have 3000 word minimum word counts. On each assignment, instructors provide detailed editorial and grammatical corrections, as well as general comments that are based on a uniformly adopted grading rubric provided to each student.
General Education Annual Course Assessment Form

Course Number/Title _____________ GEOL 107 ______________  GE Area__ R __________________________

Results reported for AY ______2015-16__________ # of sections __3___  # of instructors _____2________

Course Coordinator: _____David Andersen _______ E-mail: ___david.andersen@sjsu.edu________

Department Chair: _____Jonathan Miller________  College: ________Science_____________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What GELO(s) were assessed for the course during the AY?

GELO 1: Students will be able to demonstrate an understanding of the methods and limits of scientific investigation.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

GELO 1 was addressed in various activities and assignments. Assessment of student success took the form of short-answer responses within interactive in-class activities, in addition to a short-answer written assignment, an on-line quiz, and a field trip.

One assignment asked students to evaluate the effects of having a TV crew film an important discovery, and how the quality of their research may have been affected. This was part of a broader set of questions in which students explored the scientific methodology used by paleontologists at a real dig site. Student’s responses were generally good and their scores averaged 91% with all students participating.

This GELO is also incorporated through discussions of the scientific method and scientific theory, using specific examples of the establishment and gradual replacement of old scientific theories with their modern forms (e.g., neptunism vs. rock cycle, static earth vs. plate tectonics). Students demonstrated their understanding of scientific investigation through online assignments and in-class exam questions over the course of the semester. Students also completed a writing assignment in which they evaluated Charles Darwin’s contributions to our understanding of evolution and a writing assignment in which they selected and analyzed a scientific article about a discovery in human evolution and evaluated the article’s usage of the scientific method. Of 146 students assessed, 132 demonstrated proficiency at GELO1 by achieving a grade of 80% or higher in the course overall.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

One issue that became apparent is that some students had a hard time telling the difference
between a theory and a hypothesis. I have already taken steps to address this confusion this semester by giving different examples of each.

Part 2
To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (GELOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes, all sections of the course are still aligned with the GELO’s.

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE GELOs for writing.

n/a
General Education Annual Course Assessment Form

Course Number/Title: GEOL 004L – Planet Earth Laboratory

GE Area: B3

Results reported for AY: 2012-2013

# of sections: 16

# of instructors: 9

Course Coordinator: Ellen Metzger

E-mail: ellen.metzger@sjsu.edu

Department Chair: Robert Miller

College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 1: Students can use the methods of science and knowledge derived from current scientific inquiry in life or physical science to question existing explanations.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

This SLO was assessed by reviewing student performance and engagement for Lab 4: Climate Change? The Modern CO2 Record. This lab involves interpretation of graphs to describe short-and long-term increases in atmospheric concentrations of carbon dioxide and methane.

Student reactions to this lab exercise were discussed with the Geology 4L instructors who reported that students are interested in climate change and generally earn a B or better on this assignment, but do not exhibit a high level of engagement in this exercise. This is partly due to the fact that the most recent values given for CO2 concentrations are from the mid-2000s.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

Based on her conversations with the 4L instructors, Metzger will update this lab exercise to include more recent atmospheric data and expand it to include exploration of the current and anticipated
impacts of climate change due to rising greenhouse gas concentrations, including ocean acidification and changes in ocean circulation. New activities to complement the graph interpretation questions will include viewing of short videos and hands-on exploration of density-driven ocean circulation. These modifications are part of Metzger’s ongoing revision of the 4L lab exercises to include more examples of the interconnectedness of Earth’s atmosphere, oceans, and living things, make more connections to students’ everyday lives, and engage students in additional hands-on investigations.

Student performance on the revised lab will be assessed on the basis of average grades earned for this assignment. Discussions with the 4L instructors will be used to gain a qualitative measure of whether the revisions lead to greater student engagement.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B3 goals and student learning objectives.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 004L – Planet Earth Laboratory

GE Area: B3

Results reported for AY: 2013-2014

# of sections: 18

# of instructors: 10

Course Coordinator: Ellen Metzger

E-mail: ellen.metzger@sjsu.edu

Department Chair: Robert Miller

College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO 2: Students should be able to demonstrate ways in which science influences and is influenced by complex societies, including political and moral issues.

This SLO was assessed by reviewing Lab 4: Climate Change, in which students interpret graphs showing short- and long-term increases in atmospheric concentrations of carbon dioxide and methane. Geology 4L lab instructors reported that although students often express an interest in climate change and generally earn a B or better on this lab, they typically do not exhibit a high level of engagement in this exercise. This may be due in part to the fact the exercise does not make explicit connections with the environmental, social and economic impacts of human-caused climate change and does not relate the problem of rising greenhouse gas emissions to students’ everyday activities.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Based on extensive discussion with the 4L lab instructors, this lab exercise was revised and expanded to include 1) a hands-on activity in which students perform a serial dilution of food coloring in water to investigate the concept of parts per million and relate it to atmospheric concentrations of CO2 and 2) an investigation of sea level rise due to melting glaciers.

In an accompanying Web-based assignment, students further investigate the impacts of climate change and calculate their personal ecological footprint. They are then asked to reflect upon what actions they could take to reduce it their individual footprint.

These modifications are part of Metzger’s ongoing revision of the 4L lab exercises to include more examples of the interconnectedness of Earth’s atmosphere, oceans, and living things, make more
connections to students’ everyday lives, and engage students in more hands-on investigations. Student performance on the revised lab will be assessed on the basis of average grades earned for this assignment. Discussions with the 4L instructors will be used to gain a qualitative measure of whether the revisions led to greater student engagement.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B3 goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 004L – Planet Earth Laboratory  
GE Area: B3

Results reported for AY: 2014-2015  
# of sections: 14  
# of instructors: 8

Course Coordinator: Ellen Metzger  
E-mail: ellen.metzger@sjtu.edu

Department Chair: Jonathan Miller  
College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO #3: Students should be able to use the methods of science, in which quantitative, analytical reasoning techniques are used.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Since the last assessment of SLO3 for Geology 4L, several labs have been revised to include more quantitative analysis. This report focuses on modifications to Lab 3: “Atmospheric CO₂ Levels, Climate Change and Sea Level Rise.” The following activities have been added to this exercise: 1) serial dilutions of food coloring to illustrate parts per million, the unit of measurement for atmospheric concentrations of CO₂ and 2) calculation of the magnitude of sea level rise that would result from melting of the Greenland ice sheet. A related post-lab web assignment asks students to measure their ecological footprint using an online calculator and to interpret graphs which show what percentages of their footprint are associated with food choices, shelter, transportation, etc.

Metzger interviewed a subset of Geology 4L instructors (all of whom are graduates students in the Department of Geology) to assess the degree to which students are able to successfully complete these exercises. Instructors estimated that about 75% of their students earned a “B” or better on Lab 3, but some students required assistance with the calculations.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

Geology 4L labs typically enroll students with a wide range of quantitative and analytical capabilities and some struggle with fundamental skills such as percentages, decimals and conversion of units. Metzger will work with the 4L lab instructors to develop worked examples of calculations needed for Lab 3 (and other 4L labs) that will be presented before students begin the lab.
Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area B3 goals and student learning objectives. No action is planned.

5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

Not applicable.
Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO #1 - Students can demonstrate an understanding of the methods and limits of scientific investigation.

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

The two instructors of this course conducted the separate learning outcome #1 assessments and will therefore be discussed in separate paragraphs

(Instructor #1: Jefferies-Nilsen, 6 sections, 225 students) - Student learning outcome #1 was assessed by the evaluation of a written research paper on an earthquake or volcanic event and the factors, as determined by scientific investigations, that produced the disaster. This assignment was based on material presented in lecture, movies, textbook and one preceding assignment on the scientific methodology and evidence used to identify and evaluate the seismic and volcanic hazards.

90% of students achieved the learning outcome by earning a C or better (>71.5%) grade on this assignment.

(Instructor #2: Reed, 2 sections, 65 students) – Student learning outcome #1 was assessed through the evaluation of a portfolio of completed assignments covering Unit III of the course on the seismic hazards in the bay area. The submitted work included completed activity worksheets on the landmark scientific studies that followed the 1906 San Francisco earthquake, current state of scientific evidence for the presence and hazard potential of bay area fault zones, a video tour of the evidence of recent activity along the Hayward fault, the scientific basis for seismic risk forecasting and limits of earthquake prediction. This portfolio of student work was further enhanced in the 2013 spring semester with the inclusion of a 1-2 page-long essay on the methods and limits of science used to examine 2009 L’Aquilla earthquake in Italy, which caused 309 deaths, in addition to...
manslaughter convictions for seven scientists and engineers, and sentencing to 6 year prison terms, for a “superficial, approximate and generic” analysis of the risk prior to the earthquake. This assignment made use of lecture material, internet research and multiple reading assignments.

91% of students achieved the learning outcome by earning a C or better (>71.5%) grade on the portfolio of assignments.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

No modifications are planned at this time

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title: GEOL 112
GE Area: R

Results reported for AY: 2013-2014
# of sections: 4
# of instructors: 2

Course Coordinator: Donald Reed
E-mail: dreed@sjsu.edu

Department Chair: Robert Miller
College: Science

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by September 1 of the following academic year.

Part 1

To be completed by the course coordinator:

1. What SLO(s) were assessed for the course during the AY?

   SLO 2: Students will be able to distinguish science from pseudo-science.

2. What were the results of the assessment of this course? What were the lessons learned from the assessment?

Description of Assessment in Online and Hybrid Sections – Instructor Reed

Following an online exercise on learning outcome #2, students searched YouTube to identify examples of science and pseudoscience in scientific earthquake forecasting versus earthquake prediction. They then described these examples in terms of the identifying characteristics of science and pseudoscience in a learning group discussion with their peers.

89 out of 94 students passed the class, with a D or higher grade. Of the passing grades, 76 students achieved learning outcome #2 by earning 70% or higher on the content portion of the required online discussion, for an outcome #2 achievement rate of 85.4%.

Unfortunately, 13 of the 89 students, listed above, did not participate in this assignment and therefore did not achieve the learning outcome; 100% of the students who participated in the assignment achieved the learning outcome.

A follow up assignment, involving an essay describing the scientific characteristics of earthquake forecasting versus the problems with earthquake prediction, resulted in 95.5% of the students achieving learning outcome #2.

Overall, students performed very well on the essay assignment in which they identified scientific methods of earthquake forecasting. Participation in the initial learning discussion group was less than expected, largely because it was worth only 1.5% of their overall grade in the course and
occurred in the week before the Thanksgiving Holiday break. The essay assignment, worth 7% of their overall grade, had a much higher participation rate, and therefore experienced a higher learning outcome #2 achievement rate.

**Description of Assessment in Classroom Sections – Instructor Shostak**

SLO #2 was assessed using scientific and non-scientific (pseudoscientific) methods of predicting earthquakes.

After presenting criteria for a scientific method, how to recognize a non-scientific method, and examples of both in lecture, the class was divided into working groups to discuss a short list of possible methods and to determine which, if any, met the criteria for a scientific method. A full-class discussion followed the group work.

The criterion for achieving the outcome was a question on the final exam on whether a particular method of predicting earthquakes was scientific—and why or why not.

The passing percentage for the assessment question, and therefore the learning outcome #2 achievement rate, was 79%.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

The points available in the learning group discussion will be increased and therefore comprise a higher percentage of the overall grade to encourage all of the students to participate in this assignment.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

All sections are still aligned with Area R goals and student learning objectives. No action is planned.
General Education Annual Course Assessment Form

Course Number/Title  GEOL 112  Hazards, Risks Earthquakes and Volcanoes  GE Area R  Earth & Environ

Results reported for AY __2014-2015____ # of sections ____3_____ # of instructors ____2_____

Course Coordinator: __Donald Reed_________________  E-mail: ____dreed@sjsu.edu_________________

Department Chair: __Jonathan Miller_______________  College: _____Science____________________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What SLO(s) were assessed for the course during the AY?

SLO #3 – students are able to apply a scientific approach to answer questions about the earth and environment

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Two instructors, Reed and Shostak, provided assessment data and will be described separately.

Reed (1 section) – Students actively participate in a 90 minute-long walk along the trace of the Hayward Fault in Fremont, CA to make observations and collect measurements of ground deformation due to recent fault slip, both seismic and aseismic. Students, who cannot attend the walk, may substitute a virtual tour of the Hayward Fault, using Google Earth, and developed on the U.S. Geological Survey (http://earthquake.usgs.gov/regional/nca/haywardfault/). Students in the later group are required to make many of the same observations and collect measurements from photographs at 24 stops along the Hayward Fault between Richmond and Fremont. These data are then combined with GPS measurements of ground displacement and patterns of recent and historical earthquakes, both available from online databases at UNAVCO and the U.S. Geological Survey, to study the processes of seismic slip and aseismic creep, which are then placed in the context of earthquake probability forecasting. This research is written up in a scientific report on recent activity along the Hayward Fault and implications for seismic hazard analysis. The format of the report closely follows that of peer-reviewed scientific research journals in the geosciences.

36 of the 37 students, or 97.3% of the class, achieved this learning outcome by earning a “C” of higher grade on this assignment. The median score was 89%.

Shostak (2 sections) - The assignment required students to work in groups of 2 to 4 to determine whether their assigned GPS station in California was, in fact, moving, and if so, how fast and in what direction. The assignment required students to work with real, high-resolution (daily) time-
series GPS data from the Plate Boundary Observatory (data compiled by UNAVCO) and arrive at independent conclusions about the movement of their GPS stations. Students with stations that had experienced “setbacks” in movement (from earthquakes) had to explain their anomalous data. Class results were compiled into a map that demonstrated active tectonic plate movement in California.

Of 38 students enrolled in each section of the course, 36 students completed the assignment successfully. Grades ranged from 0 (not submitted) to 100% (correct calculations and well- reasoned conclusions). The median grade was 85-86%.

(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

Reed (1 section) - No modifications are needed at this time as the assignment has shown to be highly successful with students making their own scientific observations and measurements, integrating these data with available online data used by practicing scientists in the discipline, and then writing up the results in a scientific report. Moreover, this report is then used as the starting point for a subsequent seismic hazard analysis of their home.

Shostak (2 sections) - For the fall semester, Shostak will be using groups of 2 students to improve an individual sense of responsibility of each student to the group as a whole. To reinforce the idea of applying a scientific approach to the question of plate movement, she is also planning to follow up the homework assignment with an essay question on the midterm exam following the assignment.

Part 2

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

Yes. No actions are planned.

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

All sections taught are below the enrollment limit for Area R courses and students receive ample feedback on writing from multiple writing assignments. On each assignment, instructors provide detailed editorial and grammatical corrections, as well as general comments related to a grading rubric provided to each student.
General Education Annual Course Assessment Form

Course Number/Title __GEOL 112/Hazards of Earthquakes and Volcanoes GE Area ___R__________

Results reported for AY ______2015-2016____ # of sections ____4____ # of instructors ____2____

Course Coordinator: ___Donald Reed________ E-mail: __dreed@sjsu.edu_________________

Department Chair: __Jonathan Miller________ College: ____Science__________________

Instructions: Each year, the department will prepare a brief (two page maximum) report that documents the assessment of the course during the year. This report will be electronically submitted to <curriculum@sjsu.edu>, by the department chair, to the Office of Undergraduate Studies, with an electronic copy to the home college by October 1 of the following academic year.

Part 1

To be completed by the course coordinator:

(1) What GELO(s) were assessed for the course during the AY?

#1 – Students demonstrate an understanding of the methods and limits of scientific investigation

(2) What were the results of the assessment of this course? What were the lessons learned from the assessment?

Instructor Reed – Unit I of the course, consisting of seven class meetings, focused on the scientific methods of earthquake science. The Unit I exam on this material included two essay questions, which were phrased specifically in terms of learning outcome #1, the methods and limits of scientific investigation of earthquakes. Students were asked to describe how the key parameters of earthquakes are determined and why, including epicenter location, depth, magnitude, seismic moment, aftershock distribution and area of fault rupture, seismicity rate, average displacement on fault using seismic moment, and nature of faulting based on focal mechanism analysis. These questions amount to a total of 90 points, and 70% of this total, or 63 points, is the threshold value for achieving the learning outcome. Of the 68 students across the two sections of the course, 67 of this completed the exam; 91% of these students earned a score of 63 or higher (>70%), and therefore achieved the learning outcome.

Instructor Shostak – The combined score of three assignments: (1) Hayward fault field trip assignment, (2) Triangulation homework activity, and (3) 7th Street field trip, was used to assess student achievement of this outcome. Each assignment asked students to make observations, acquire and analyze data, both visual and numerical, and then present a conclusion based on this analysis. The Hayward Fault assignment required students to develop a geologic map of the 1868 Earthquake rupture trace based on field observations; the Triangulation assignment required students to determine the epicentral location of an earthquake by analyzed seismogram, using S-P wave travel-travel graphs; and the 7th Street trip required students to identify residential structures most likely vulnerable in the next large earthquake in the Bay Area, and write observations, analytical procedure, and conclusions in a report. Out of the 75 students across the two sections, 87.9% achieved the learning outcome by earning a passing score or higher.
(3) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.

**Reed** – no modification planned except to emphasize all students to consider the material in terms of the method and limits of scientific investigation.

**Shostak** - In Fall 2015, 95% of students completed the Hayward Fault field trip assignment. A lower percentage of students achieved SLO #1 in the Spring 2016 course primarily due to students’ choosing not to complete assignments, particularly the Hayward fault field trip (80% completed this assignment in the spring). For the current semester, I shall repeatedly emphasize the importance of the field trip for understanding firsthand the scientific methods employed by seismologists in the field. If the percentage completing the trip does not improve, in the future I shall assign a greater grade weight to the field trip. As a note, the field trip has been set up as a self-guided trip for students who cannot go with the class, and I allow students to complete the assignment until the day of the final exam.

**Part 2**

To be completed by the department chair (with input from course coordinator as appropriate):

(4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (GELOs), Content, Support, and Assessment? If they are not, what actions are planned?

(5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE GELOs for writing.