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MEMORANDUM

ATTENTION Senate **DATE** November 16, 2011
FROM Jon Driver, Vice-President, Academic and Provost, and Chair, SCUP **PAGES** 1/1
RE: External Review of the Department of Earth Sciences (SCUP 11-46)

At its October 26, 2011 meeting SCUP reviewed and approved the Action Plan for the Department of Earth Sciences that resulted from its External Review.

Motion

That Senate approve the Action Plan for the Department of Earth Sciences that resulted from its External Review.

encl.

c: J. MacEachern
C. Cupples



OFFICE OF THE ASSOCIATE VICE-PRESIDENT, ACADEMIC AND ASSOCIATE PROVOST

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www.sfu.ca/vpacademic**MEMORANDUM**

ATTENTION Jon Driver, Chair, SCUP **DATE** October 18, 2011
FROM Bill Krane, Associate Vice-President, Academic **PAGES** 1/1
 and Associate Provost
RE: External Review of the Department of Earth Sciences

Attached are the External Review Report on the Department of Earth Sciences and the Action Plan endorsed by the Department and the Dean.

Motion:

That SCUP approve and recommend to Senate the Action Plan for the Department of Earth Sciences that resulted from its External Review.

Following the site visit, the Report of the External Review Team* for the Department of Earth Sciences was submitted in April 2011.

After the Report was received, a meeting was held with the Dean, Faculty of Science, Department Chair, and the Director of Academic Planning and Budgeting (VPA) to consider the recommendations. The Department then prepared an Action Plan based on the Report and these discussions. The Action plan was then submitted to the Dean on May 27, 2011. The Dean endorsed this Action Plan.

The Reviewers concluded that;

'Overall, the Department is doing well and is a credit to the Faculty and University. There are no major weaknesses. The Department ranks well in comparison to geoscience departments of similar size in Canada, and its reputation in environmental geology is one of the highest in the country. The interests of the Department are best served by remaining in the Faculty of Science, but there is much scope for collaborative, respectful ties with the Faculty of Environment and other departments in the Faculty of Science in both teaching and research.'

SCUP recommends to Senate that Department of Earth Sciences be advised to pursue the Action Plan.

Attachments:

1. External Review Report – April, 2011
2. Department of Earth Sciences External Review - Action Plan

*** External Review Team:**

Robin W. Renaut (Chair), Professor, Department of Geological Sciences
University of Saskatchewan

Iain Samson, Professor and Head, Department of Earth and Environmental Sciences
University of Windsor

Carolyn Eyles, Professor, School of Geography & Earth Sciences
McMaster University

George Agnes (Internal) Professor, Department of Chemistry and Associate Dean of Graduate
Studies

CC Claire Cupples, Dean, Faculty of Science
 James MacEachern, Chair, Department of Earth Sciences

External Review Report

Department of Earth Sciences, Simon Fraser University

April 2011

INTRODUCTION

The external review team visited the Department of Earth Sciences from March 9 to 11, 2011, having received the Self Study Report and accompanying documents about a month earlier. The members consisted of Dr. Carolyn Eyles (McMaster University), Dr. Robin Renaut (University of Saskatchewan, Chair), and Dr Iain Samson (University of Windsor). Dr. George Agnes (Department of Chemistry) served as the internal member, providing valuable support to the committee. The three days were spent interviewing faculty, adjunct and teaching staff, graduate and undergraduate students, office and technical staff, librarians, and members of senior administration. A tour of the Department and facilities was also made.

The primary mandate of the committee was to assess the undergraduate and graduate teaching programs, the quality of faculty research, the degree of participation by Department members in administration and dissemination of knowledge, the overall 'environment' of the Department, and the future directions that the Department has planned.

A series of specific questions were also considered, and these are documented later in the report.

UNDERGRADUATE PROGRAMS

The numbers of undergraduate students taught by faculty and instructors in Earth Sciences has increased considerably since the last departmental review in 2004 (from 578 to 1473). This has been accomplished largely by the addition of several new large-enrolment, first-year courses that address the need for Writing, Quantification, Breadth (WQB) courses accessible to all SFU students. The number of Majors also appears to have increased over the 2004–2010 time period (from 43 to 81). However, the number of students graduating from the program each year has stayed fairly consistent at between 12 and 16, with a drop to nine students in 2010 (Appendix I, p. 3). In addition, the number of students entering the Minor program in Earth Sciences has dropped dramatically in recent years, with three students registered for the 2009-10 session.

Overall, the standard and quality of teaching in the Department seems to be high; students interviewed are very satisfied with their program, and enjoy the small class sizes and general collegiality in the department. There is an expectation of high teaching standards from all instructors within the Department and a general desire to provide the best educational experience possible for the students. The students themselves appreciate the many opportunities provided to them to engage in fieldwork and to apply the knowledge learned to 'real world' situations. In the latter context, the Department benefits from the excellent contributions made by a number of adjunct faculty from local government agencies, academia, and industry. Most students in the program are able to acquire summer employment in their field of interest and employment opportunities after graduation are very good. There does not appear to be any need for a co-op program in the Department of Earth Sciences. With current enrolment, the provision of undergraduate teaching space, though not ideal, is adequate.

A number of issues need to be addressed regarding the undergraduate programs. These issues relate to curriculum, student recruitment, and teaching resources.

Curriculum

Major program

The Department currently offers three streams for students to follow as part of the B.Sc. Major program: Geology, Environmental Geoscience (both of which allow students to satisfy the academic requirements for professional registration in the Association of Professional Engineers and Geoscientists of BC: APEGBC) and General Earth Science. However, the curricula followed by these three streams have not been thoroughly reviewed in terms of overall content, learning objectives, or pedagogy for some years. Curriculum change has reflected the changing composition of the faculty rather than the needs of the professional geosciences community or society. As stated in the departmental self-study report (p. 58): “The undergraduate curriculum has evolved considerably over the years in order to accommodate the expertise of incoming faculty.” New courses have been added to the curriculum, but the overall structure and content of the programs have not been addressed.

APEGBC has recently (2011) changed the requirements for professional registration to align with the Geoscientists Canada knowledge requirements (<http://www.apeg.bc.ca/reg/geosyllabi.html>) and the Department now needs to undertake a full and comprehensive review of the undergraduate curriculum. A thorough curriculum review will allow the identification of courses that need to be maintained, courses that are no longer required by graduating students, and new courses that should be considered for inclusion in the curriculum (e.g., metamorphic petrology, biogeochemistry, geostatistics, geographic information systems (GIS)). In this context, course offerings in other departments that may enrich the Earth Sciences programs should be explored (e.g., environmental chemistry, ecology, and toxicology courses). This type of curriculum review will ensure that the program content is kept up-to-date and relevant, and provides the appropriate amount of flexibility and choice for students. Regardless of external (APEGBC registration) requirements, the curriculum planning process should be strategic and should consider the knowledge base, skills, and experiences of faculty. The organization of a series of off-campus retreats, facilitated by members of Teaching and Learning Centre, should be considered when planning the curriculum revision process.

A revised, more flexible and streamlined program may attract additional students into the Majors streams and may also remove scheduling issues that students have experienced (and complained about). The review of individual courses and course content may also allow the consolidation and amalgamation of courses and (or) their scheduling in alternate years. The Department currently offers a total of 41 undergraduate courses, many of which are upper-level courses with low enrolments. The creation of fewer, more relevant, and better-populated courses is desirable. Tracking of skills development (discipline-based skills and transferable skills) through the curriculum, and careful examination of the prerequisite structure for upper level courses, should also be included in the curriculum review process. Attention also needs to be given to the scheduling of courses. To provide the full suite of courses that students need to graduate, the Department should ensure that ‘core’ (required) courses are consistently offered, and take priority over the scheduling of optional courses. Fourth-year field courses that involve expensive (international) travel should be optional and not required by the Major program. Students should be given plenty of notice of these field courses to allow financial planning. A

thorough curriculum review is also essential to provide the framework for the proposed plan to change the three streams of the existing Major program into separate degree programs (p. 65 of the Department's self-study document), although the committee feels that few (if any) advantages may be gained by having more, but smaller Earth Sciences programs.

Minor program

The curriculum review process should also include examination of the structure and content of the Minor program in earth sciences that is attracting very few students. This review should identify discipline areas in which a Minor in earth sciences would complement the Major curriculum and would be attractive to students. There seems to be an untapped opportunity to create a Minor in earth sciences that would complement environment programs.

Opportunities for collaboration

There appear to be many opportunities for collaboration with other units within the university that would strengthen the undergraduate programs of the Department of Earth Sciences. In particular, development of a collegial dialogue with the Department of Geography must be pursued urgently. Collaboration between the departments of Geography and Earth Sciences could allow the development of enhanced environmental (geo)science programming that would benefit the university as a whole. Incorporating a range of courses from each department into both Earth Sciences and Environmental Science curricula (e.g. GIS, Remote Sensing, Geochemistry), and the provision of consistent student access to these courses, would significantly enhance the quality of both programs. Dialogue between the two departments would also allow the content of some courses to be enhanced and better aligned to meet the needs of a more diverse student audience.

Student recruitment

In order to inform prospective students of the opportunities for study in the Earth Sciences, undergraduate programs offered by the Department of Earth Sciences need to be given much greater visibility on the university website (e.g., 'Areas of Study' page). In addition, as most recruitment into undergraduate programs in Earth Sciences occurs within the university, the Department should work with the Dean to explore ways of enhancing the visibility of EASC 101 to science majors as a course option. The Faculty of Science should also consider making EASC 101 a requirement for students in the General Sciences program. Faculty members from the Department of Earth Sciences should be fully engaged in discussions regarding the restructuring of the General Science program. The Department could also enhance outreach activities to local high schools by engaging members of the Undergraduate Earth Sciences Student Union.

Teaching resources and quality of teaching

The overall quality of teaching in the Department is high. The only issue raised by students was that some instructors should be encouraged to give more detailed feedback on submitted work that extends beyond the single mark. The most effective teachers in the Department should be consistently assigned to teach EASC 101 because this is an important recruitment course. The Department is encouraged to nominate effective instructors for appropriate teaching awards. Efforts should also be made to give instructors and teaching assistants sufficient advance notice of teaching assignments, and to assign teaching duties according to the background, skills and

abilities of the instructors and TAs. The introduction of more team-taught or shared courses would enhance flexibility of teaching schedules and could provide more effective scheduling of vacation time for teaching faculty. In comparison to other universities, TA provision is exceptionally high and very healthy, although the number of hours of work required from a TA is more than at other institutions.

However, the teaching load and scheduling of courses is an issue for teaching staff, who have insufficient time between teaching assignments for reflection and preparation. Teaching staff also require more stability in their teaching assignments as these are often not determined sufficiently far in advance to allow proper preparation. Teaching faculty could be more effectively utilized in the Department through greater involvement in curriculum planning and dissemination of information about pedagogical approaches and techniques. Teaching evaluation tools are not always appropriate for teaching faculty and a purpose-designed evaluation form is needed for the laboratory instructor.

Students gain access to course materials in a variety of ways via the departmental website. The Department is encouraged to establish a *single* web location for class notes and other materials that is hosted on a campus source server rather than the Department server. Instructors should investigate ways to more effectively use tools on the learning management system (WebCT) to collate grades, post notices, accept assignments, etc. Students should also be encouraged to consult the Departmental website more frequently for information about departmental events such as seminars.

The undergraduate teaching space available to the Department of Earth Sciences is adequate given current enrolments. However, discussion should take place with the Dean of Science regarding reallocation of Room 7000.1, TASCII, which appears to be underused at present, to Earth Sciences. Reallocation of this room would provide more effective and flexible use of teaching space in TASCII. Lecturing in laboratory classrooms does occur at present but should not be continued if additional laboratory classes/sections are scheduled to accommodate future higher enrolments.

RESEARCH

The quality of research is high in all of areas in the Department. It is in a strong position in that every one of the non-teaching faculty members is active in research, publishing in peer-reviewed journals, and the majority has the solid foundation of an NSERC Discovery Grant. This is supplemented to varying degrees by funding from a number of sources, including government agencies and private industry. The latter will almost certainly have to be pursued more vigorously in the future as the success rate for NSERC Discovery Grants decreases, and as NSERC puts increasingly more emphasis on other grant programs (such as CRDs).

The Department of Earth Sciences at SFU is not unique in being very diverse in the research expertise of its faculty members. This is a necessity to be able to provide a comprehensive undergraduate program, but leads to challenges. The Department has self-organized into a series of 'research groups', which is how the site visit discussions were structured. This approach has distinct advantages for some people, and for the Department as a whole. It provides identity to those with similar interests and provides for increased communication and interaction between subsets of graduate students on a semi-formal basis. It also helps in attracting funding. However, some of the 'groups' comprise single faculty members and their graduate students, and in some

cases post-docs. This is almost inevitable in any earth sciences department organized along these lines. The potential disadvantage of this approach is isolation and lack of communication between groups. Our impression is that more interaction between groups, and indeed among the Department as a whole, is needed and should be encouraged. One mechanism for this is the departmental seminar series, and the attendance of the majority of faculty and graduate students on a regular basis. A suitable seminar room closer to the Department would help in this regard, but is not a significant hindrance. In addition, and related to this, is the lack of suitable common space for the graduate students to interact amongst themselves and with faculty. We understand the space limitations, but the university needs to consider how to accommodate these needs to help fertilize this growing and successful graduate and research program.

Ultimately, a university department tends to succeed when the members are a coherent group having a clear vision (even if broad), and fail when 'fractionation' occurs. We got the impression that everyone in the Department gets on well and are collegial, but regular gatherings of faculty, graduate students, and senior undergraduates around interesting research discussions would help to gel the Department as a whole and perhaps give it more internal identity (see also comments about departmental meetings in this regard).

By its very nature, earth sciences as a discipline is very broad in that it studies all aspects of the Earth, from a multitude of perspectives, and using knowledge and techniques from all the other branches of science and mathematics. The terms of reference ask us to consider new or emerging areas that could be pursued, and possibilities for partnerships with other departments or universities. As noted above, the SFU department reflects much of the breadth of earth and environmental science, but there are many possible new directions that the Department could consider as they evolve. It would be presumptuous of us to identify or recommend any one or two areas for growth, as such decisions have to be made in the context of strategic planning that includes all aspects of a department's activities, and in the context of the areas affected by retirements. In the absence of a strategic plan and of information on imminent retirements, we cannot make specific recommendations. Having said that, we will point out that there is a growing need to embrace other disciplines and to develop research programs that lie at the interface between the traditional disciplines. Thus, exciting opportunities lie in collaborating with chemists, biologists, physicists, etc., and the Department should consider such areas as it moves forward in developing strategic plans. An excellent example is geomicrobiology-biogeochemistry, which is a growing field that is breaking new ground in understanding a myriad of earth environments and can contribute to teaching and research programs in mineralogy, geochemistry, soil science, microbiology, among others. At the same time, the University has to recognize innovation in this regard and foster and reward such interdisciplinary initiatives from the point of view of administrative barriers and turf protection in traditional disciplines.

THE GRADUATE PROGRAM

The small size of some research groups and the breadth of the Department have also led to issues around graduate course offerings. Not surprisingly, the perspective from different groups was different — some thought that graduate course offerings were fine, others did not. Most courses are very specialized, and most have had small numbers of students enrolled. Some students had difficulty in meeting their course requirements due to the small number of relevant courses that were available to them. Again, this is not a unique situation in many departments.

Access to courses through the Western Dean's agreement is working well, with most courses having been taken at UBC, albeit not very many. Developing more jointly taught courses with UBC might be possible and should be considered. This exposes students to a broader academic environment but obviously has logistical limitations.

A large number of courses are listed in the calendar (26 by our count, excluding special topics), and 36 different courses were offered in the seven years between 2004 and 2010. We recommend that the Department consider rationalizing these and developing some graduate courses that would interest a broader cross-section of students. These could be team-taught and offered on a more regular basis than the more specialized courses. This would provide efficiency (larger classes), more regular offerings for students, and more interaction between students from different groups (cf. comments above about the research environment). As an example, in a broad-based course in recent advances in geochemistry, students with a common background or interest in geochemistry could discuss topical issues in geochemistry as applied to a variety of processes or environments, which could range from the mantle to groundwater. This kind of cross-fertilization and exposure can be very beneficial to graduate students (and faculty); it is too easy to become myopic about our own little corner of earth science. Guidance on proposal writing was requested by the students, and we suggest it could be incorporated into a revised and updated version of EASC 600-0 (Introduction to Graduate Studies).

Some faculty members and groups have good linkages with the external communities, including resource companies, academia, and government, most notably the Geological Survey of Canada. As part of this, the Department has an excellent active Adjunct Professor component, which provides some important contributions to graduate teaching and research expertise, and offers graduate students the opportunity for valuable interaction with the broader earth science community. This should be fostered, and where possible, expanded and broadened.

The graduate program has seen steady growth that reflects the recent increase in the Department's faculty complement, and the high quality of its research. The PhD program is new and is likely only just getting to a steady state. Both the MSc and PhD programs now have very healthy enrolments with a good balance between the two. Times to completion for MSc students are close to three years (8.6 semesters), and could be reduced.

Funding levels for graduate students are equitable across the Department, and although adequate, are probably low for someone living in Vancouver. This is certainly a concern for the graduate students. The minimum guaranteed amounts are comparable to, or lower than, other departments that are located in places with lower costs of living. This decreases the competitiveness of the SFU faculty in attracting graduate students. The Department, in partnership with the university administration, should consider increasing the minimum stipend. Although this would allow support of fewer students, it would make them more competitive, and provide levels of funding that are commensurate with living in Vancouver. Ideally, this would be achieved through a combination of increased TA funding, graduate scholarships (tuition?), and from research grants. Another option would be to consider fewer instruction hours for the same money, unless such issues are constrained by collective agreements. Such an adjustment may also help in completion times, as students would theoretically be spending more time on their research.

Overall, the graduate students are content with how the Department is run and the way they are treated. The graduate secretary is held in high regard, and has a good relationship with the

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students. However, the graduate student body expressed concerns about the flow of information from the Department, through the Graduate Chair, to the students. In general, it should be easy for graduate students to get the information and advice that they need to successfully complete their degrees in a timely manner, but it appears that this is not always the case. This includes transparency in the communication of information regarding criteria for awarding graduate scholarships and about course offerings. Another issue is in the annual student reviews, where there is concern about the uniformity of what is expected (standards) and how the reviews are conducted. Related to this, the graduate section of the website is focused on recruitment, and does not appear to be designed to provide information for current students. A separate section on the website along these lines would be helpful, including, for example, an FAQ page, and clear statements about criteria for graduate scholarships and the procedures for annual reviews. Some graduate students expressed a desire for more opportunity to interact with other departments, including being able to TA, if qualified. To foster this, one approach would be to collaborate with other units to bring in seminar speakers in areas of mutual interest. This comment extends to collaboration with UBC and the University of Victoria to share the costs of bringing speakers to southwestern BC.

OFFICE AND TECHNICAL STAFF

The office and technical staff work efficiently and effectively in support of the Department. A collegial atmosphere is evident and positive comments were received from students and faculty alike. The staff members are mutually supportive, assisting each other in times of need or absence, and all make major contributions to the smooth running of the Department. The present number of staff appears to be appropriate.

RESOURCES AND SPACE

Library

The faculty and graduate students are generally content with the resources and operation of the Library. Most are satisfied with the selection of core geoscience journals that are currently received and the effectiveness of the interlibrary loan service. Some concerns were raised about online access to specific journals, and to older runs of journals. However, in some cases, holdings of those journals are present as hard copy in the Library. The librarians will try to address specific requests if possible.

Space

In common with many departments, space allocation is a recurrent issue. As already noted, the existing space is adequate but not ideal. If the Department increases enrolment significantly or any new large equipment is acquired, space will become a more pressing concern. A planning process on how to cope with future potential space issues should be undertaken well in advance. Specific space issues include those related to teaching, graduate student accommodation, and places for interaction between faculty, staff and students.

Teaching related space

Many faculty members commented on the limited teaching space available in the Department. At times, finding a free room to hold a class or an unscheduled meeting is difficult. The

seminar/conference room is used frequently for graduate classes (for which it is poorly suited) and unscheduled discussions, and at times, this room is unavailable. Apart from first-year courses, most lecture classes are held in the laboratory classrooms in the TASC1 building and the other laboratories assigned to Earth Sciences in neighbouring campus buildings. The use of laboratory space for lectures has advantages — if, for example, hand specimens are shown—but this limits access for undergraduate students who wish to complete laboratory assignments during daytime work hours. Moving some courses out of the Department into general lecture rooms that might be available elsewhere on campus would relieve pressure on some of these heavily used teaching laboratories. More flexibility in classroom usage is desirable.

Graduate student accommodation

Graduate students are housed in offices or in laboratories linked to their supervisors. Some find this acceptable; others find it less than ideal, particularly if instruments or procedures in that laboratory (or an adjacent one) generate a lot of noise, dirt or dust. The present situation is manageable, but graduate space will quickly become a problem if graduate enrolment increases.

Need for more communal space

The Department has few communal areas where faculty, staff and students can meet informally. The ‘coffee room’ is little more than a kitchen. Informal discussions in the Department occur within groups rather than between groups. Graduate students and postdoctoral fellows, in particular, do not mix among themselves easily, so chances for interchange of ideas are limited. The only open space suitable for partitioning (e.g. glass screens) to form an open lounge seems to be outside the General Office, but undergraduate students often use this area between classes. The committee feels that communication among all parties would improve if such a communal area could be found and was used regularly for discussion and coffee.

Access to other space in TASC1

Departmental seminars take place several minutes walk from the Department and this has an impact on attendance both by faculty and students. It would be beneficial if a suitable room were found nearer to the Department. We encourage the Department to explore the possibility of sharing a nearby AV-equipped room with Computer Science and (or) be more flexible with timing of seminars.

Equipment

Department bus

Several faculty members consider replacement of the departmental bus a priority. Students were unanimous in enthusiastically endorsing the experiential learning opportunities that the Department offers through its varied field trips.

Few Canadian geoscience departments own buses. The bus is used for student field trips of variable duration, and several faculty and staff have the necessary driver’s license. Usage is high at specific times, but the bus is parked for extended periods. If funding were available, replacement of the bus might be justified — it is highly beneficial for geoscience students to see a wide range of geological and geomorphological features in the field.

Alternative options for replacing the bus should be investigated. These include:

1. Sharing the cost of purchase and maintenance of a bus with other science departments (e.g., Biology). The downsides to this model are the shared responsibility for cleaning and upkeep, and common demand at peak periods.
2. Rental of buses from commercial operators (typical for many other departments).
3. Usage of minivans. A disadvantage is the increased risk when using several vehicles and the need for more safe drivers.
4. Seeking sponsorship from the resource industry or other potential donors for a replacement vehicle. In return, donor companies could display their logo(s) prominently on the bus. Undergraduate students should be involved in the fund seeking effort because they would be the primary beneficiaries. The review committee favours this as the first option to investigate.

Microscopes

The case for acquisition of six new teaching microscopes is strong, and would increase if undergraduate enrolment rises. In the short term, however, the Department should consider moving some lecture classes out of TASC1 to improve microscope access for undergraduate students, and increasing the number of laboratory sections.

ADMINISTRATION

The administrative structure of the Department is formalized in the Departmental Constitution. Revisions to the constitution were initiated following the last departmental review in 2004 allowing some changes to be approved by the Department early in 2006. However, the full constitution document was not revised at this time and there is some concern that the rules and procedures outlined therein may not be appropriate for the effective administration of the Department in its present form. Changes to the constitution document have been recommended by the Chair but have not yet been given departmental approval. Although formal procedures are in place, aspects of departmental governance and administration appear to be fairly lax. Few departmental meetings are held and not all faculty are present or required to be present. Some notices are sent by e-mail, but not always read. Some information is put on the departmental website, but many faculty and students admit that they rarely consult it. This in turn can lead to misunderstandings, suspicion, confusion, differing expectations, and injection of opinions of entitlement. More efficiency in communication and discussion is very desirable.

The Department should be strongly encouraged to adhere to the processes and policies outlined in the existing constitution regarding the convening of at least one or two departmental meetings each term where all faculty can raise issues and hold discussion. When major issues are discussed (e.g. curriculum or program changes), attendance should be mandatory. If a meeting is related to teaching, the teaching staff or a representative should be invited to attend and to contribute their ideas. There may be cases when office and technical staff and students should also be invited to attend departmental meetings.

We recommend that the Department conduct a formal review and revision of the Department Constitution to ensure that this document is an appropriate guide for effective and collegial administration and decision-making processes.

ITEMISED TERMS OF REFERENCE FOR REVIEW COMMITTEE

1. Should the Faculty of Science include Earth Sciences courses as required components of other Science programs, as recommended by Senate? What impact might this have on numbers of majors and minors in Earth Sciences?

Across Canada, earth science receives little exposure in high schools. Consequently, incoming students are often ignorant of the subject, its place among more familiar sciences, and how it differs from geography. Few students appreciate its interdisciplinary nature in blending physics, chemistry, biology and environmental science, and that it is a quantitative discipline. We strongly support the integration of earth science courses as required components in other Science programs. In British Columbia, more than many other provinces, earth science plays a central role in the environment (e.g., earthquakes, landslides, tsunamis) and the economy (e.g., fossil fuels, mineral deposits). Several faculty members in the Department of Earth Sciences are recognised nationally and internationally for demonstrating the relevance of earth science to society, and full advantage of such strengths should be taken.

Enrolment would almost certainly increase if earth science courses became required components in other Science programs, but that alone should not be the primary reason for including these courses as required components. All science students should be exposed to the many possibilities for future research and exploration that the earth sciences can provide, particularly in British Columbia. Many students enter undergraduate science programs limited by their high school science experiences and unaware of the opportunities in the earth sciences. Exposing freshmen students to the possibility of study in the earth sciences could more equitably distribute undergraduate student numbers between departments in the Faculty of Science and reduce the pressure on overprescribed programs that are viewed as the sole route to medical school. The Major and Minor programs in the Department of Earth Sciences would certainly benefit from the inclusion of earth science courses as required components in other Science programs, and the Faculty would benefit from more evenly distributed student enrolments and students who are more satisfied with their program choices.

2. Should the Department consider forging stronger linkages and developing joint programming initiatives with other Faculties at SFU? Advise on a preferred strategy to strengthen linkages with other BC and Canadian institutions.

We agree with most of the faculty that the Department of Earth Sciences should remain in the Faculty of Science. We see no advantages for Earth Sciences moving to the Faculty of the Environment, where it would lose some of its identity, independence and potentially funding. Had the new model included the Biology Department, a key contributor to the field of environmental science, the case for joining the new Faculty might have been stronger.

Given the inherently interdisciplinary nature of earth sciences there are many opportunities for collaboration with other units and Faculties at SFU. Linkages are currently being developed with the Department of Chemistry with respect to a proposed joint Major degree focusing on geochemistry. Earth Sciences, in conjunction with Geography, led the development of the Water Science stream within the Environmental Science program and has contributed to the program for a number of years. Unfortunately, interdepartmental barriers that exist between the Department of Earth Sciences and the Department of Geography block the most productive

potential collaborations. These barriers are particularly strong and limit effective curriculum design, scheduling and student access to courses. Both departments should aim to reduce overlap in course content, identify gaps in knowledge and skills development, and recognize that they do their students a disservice by limiting access to each other's courses. All departments need to appreciate and mutually respect the contributions that different discipline areas can provide in comprehensive disciplinary and interdisciplinary programs.

3. Evaluate the Graduate Program and advise whether existing and/or new partnerships with other universities should be pursued. Should the Department consider developing joint graduate programming with other SFU departments? Should a course-based or co-op Master's degree be considered?

The graduate program is reviewed above. Overall it is a high-quality program that has grown substantially over the past seven years. Recommended refinements include a rationalization of graduate course offerings with the development of some broader-themed courses, increased levels of funding for students, improved communication of information about some departmental procedures and decisions via the Graduate Chair, and a modified web page.

Strong links already exist in some areas between the Department and UBC in graduate level teaching and research (shared analytical facilities). Although SFU students commonly attend courses at UBC, the reverse is not the case. The Department might consider developing formal joint graduate courses with UBC, especially in areas where expertise is unavailable at UBC.

The possibility exists for the Department to become involved at the graduate level in joint initiatives with the Faculty of Environment. Respectful discussion between the various parties is needed during planning. The possibility of joint graduate courses with (physical) Geography exists if the existing barriers to collaboration and turf protection can be overcome. Such courses would increase efficiency (larger classes), interaction and idea exchange between students, and both departments would benefit.

A course-based Master's program is an option that merits discussion. Possibilities exist for offering courses in the resource and geo-engineering sectors for students planning careers in those areas, and for professionals in those sectors who wish to upgrade their qualifications and update their knowledge in those fields. However, the existing programs are successful, and still growing and stabilizing, such that developing a course-based degree (or co-op program) should not be a high priority due to the many employment opportunities available to students.

4. Evaluate the Department's performance in building relationships and engaging with the external community, particularly the private sector. Suggest future priorities and an implementation strategy for acquiring additional financial support and developing research partnerships.

The Department already has very good relationships with the private sector and engagement with the external community, much of it brought about through the external activities of the research chairs. There is strong input to the Department by adjunct faculty associated with the Geological Survey of Canada.

In some areas, the Department is in competition with UBC for external financial support, particularly from traditional mineral resource companies, some of which have long-established

relationships with UBC. Nevertheless, there are many opportunities to obtain such funding at the present time, especially through NSERC-CRD grants. There is an even greater chance of success in those areas where the Department is not in such direct competition, such as in the fields of petroleum geology, environmental geology, and hydrogeology.

Regarding contracts with industry, concern was expressed about high overhead on student salaries, which makes SFU faculty less competitive with UBC. The University is encouraged to review this issue. The breadth of the Department means that applications for support are more likely to succeed when approaches made by individual research groups rather than by Department as a whole.

5. To what extent could the Department grow within its current resources and space? Assess the impact of faculty retirements on the mission of the Department and advise on the best approach for making faculty renewal decisions.

This is addressed in the next section. There is some capacity for growth (20–25%?) in undergraduate enrolment, but only if plans are in place to accommodate this growth. The potential for growth in the graduate program is limited both by funding and available space to house more graduate students.

Assessing the impact of faculty retirements on the mission of the Department requires in depth discussion and creation of a strategic plan. There is some departmental interest in hiring a metamorphic petrologist as a replacement for a recent retirement (Peter Mustard) to introduce a new course in this area. However, the identification of specific areas of expertise for future hires cannot be conducted without a full curriculum review and the creation of a strategic plan, within which the rationale for areas for growth and development are clearly articulated. The curriculum review process may allow consolidation of teaching duties from existing faculty and provide opportunities for the identification and development of more innovative areas for future hires.

THE NEED FOR A STRATEGIC PLAN

The Three-Year Plan (2010-13 – Appendix B) outlines the position of the Department at the time of writing (2009), but does not discuss in detail many of the important issues that the Department will face in the near future. One impression that the committee reached is that the Department has long been deferring discussion of some possibly contentious matters. A lack of open debate, in turn, has led to some loss of direction with respect to programs and curricula, faculty renewal, and other issues such as space allocation. There is an urgent need for the Department collectively to address a number of issues including:

1. What is the optimum size of the undergraduate program? What is a realistic enrolment target? Growth is emphasized throughout the Self Study Report, but growth also increases the demands on faculty and teaching staff and their time, space, and other resources. Is growth without additional resources going to benefit the Department or introduce more problems? How many more students can the Department accept if new resources are not forthcoming? How will growth affect student education and experience?

2. The curriculum at both undergraduate and graduate levels should be re-examined. As noted, the undergraduate program is missing important courses (e.g., GIS) that are standard in many other earth science other programs, and commonly in demand by employers. The new requirements of the APEGBC should also be taken into account.
3. The Department wishes to maintain its independence, but at the same time is not taking full advantage of possible links with other departments on campus. The Water Science initiative is an exception. Discussions with Chemistry have also been productive. The Department should consider strengthening links with the other science departments, especially in interdisciplinary areas of growth such as biogeochemistry. Opportunities also exist for closer collaboration with Biology and Geography. The Department needs to be forward thinking and take a leadership role in program development within the Faculty of Science (for both graduate and undergraduate programs).
4. No faculty retirements are immediately imminent, but it is not too early to discuss the possible research areas of faculty replacements. Will the Department stay with its present research strengths, expand in other research areas, or move into completely new, perhaps interdisciplinary, areas? Should the Department take on any new faculty who cannot teach part of the core program? Any identification of specific areas of hiring (e.g. metamorphic petrology) is premature without a well thought out strategic plan that fits with the broader plans of the Faculty of Science and the University. However, a much stronger case for future (new) hiring and replacement of retiring faculty will be made if a clear, longer term strategic plan for the Department is in place.

LIST OF MAIN RECOMMENDATIONS

Undergraduate program

1. The Department should conduct a comprehensive undergraduate curriculum review as soon as possible.
2. The Department should enhance collaborations with other units on campus.
3. The University and Department should discuss how to make the simple modifications to the design of the university website that would increase the visibility of Earth Sciences undergraduate courses and programs.
4. The Faculty of Science should consider making EASC 101 a requirement for all students in the General Sciences program.
5. Teaching assignments for all Departmental instructors should be stabilized with the most effective instructors assigned to EASC 101. Under normal circumstances, all faculty and teaching staff should be given ample notice of their assignments (consult university policy).
6. The use of a single web site/WebCT for all course materials should be considered.

Research

1. The Department should explore ways to enhance interaction between the different research groups, by encouraging better attendance at seminar series, and by working with the University to locate a suitable common space for graduate students.
2. The University and Department should encourage and enable more interaction in collaborative research with faculty from other departments. This is already happening (e.g., Water Science), but other opportunities may exist.

Graduate program

1. Rationalize graduate course offerings and develop some broader-themed courses that are offered on a regular basis.
2. Discuss how to increase levels of funding for graduate students.
3. Improve communication about departmental procedures and decisions via the Graduate Chair and modify the departmental web page to make it more useful for enrolled graduate students.

Space and resources

1. Discussions should be held at the Decanal or higher level over the use of Room 7001, TASCII, currently assigned to Computer Science but apparently little used. Transfer of the room would probably have little impact on Computer Science, but would significantly improve space problems in Earth Sciences (e.g., as a small classroom or laboratory, or common room for graduate students).
2. The Department should review the current use of the laboratories used for teaching most upper level (200-400 level) classes, and determine if some could be taught nearby elsewhere on campus.
3. The Department should undertake a cost-benefit analysis of the various options for replacing (or not replacing) the bus. If the bus is to be replaced, seeking external funding should be the first approach.

Administration

1. The Department should conduct a formal review and revision of the Department Constitution to ensure that this document is an appropriate guide for effective and collegial administration and decision-making processes.
2. The Department should adhere to the processes and policies outlined in the existing constitution regarding the convening of at least one or two departmental meetings each term, to provide for more regular discussions about strategic issues and for flow of information.

SUMMARY COMMENTS

Overall, the Department is doing well and is a credit to the Faculty and University. There are no major weaknesses. The Department ranks well in comparison to geoscience departments of similar size in Canada, and its reputation in environmental geology is one of the highest in the country. The interests of the Department are best served by remaining in the Faculty of Science, but there is much scope for collaborative, respectful ties with the Faculty of Environment and other departments in the Faculty of Science in both teaching and research. It may take direction from senior administration to break down existing barriers and turf protection (e.g. unnecessary prerequisites that exclude students from courses), but the students will certainly benefit if this happens, and the scope for innovative attractive programs will increase.

The undergraduate program has expanded and the students are generally satisfied with their education. Most students choosing to pursue careers in geoscience are finding employment soon after graduation. The graduate program is maturing, but problems of space, funding levels and course offerings need to be addressed. Equal standards need to be ensured in supervision of graduate students and in preparation of their annual reports. The research profile and research productivity are generally high, competitive with geoscience departments of similar size, and most faculty members receive respectable levels of external funding. Some faculty members are leaders in their fields.

Several issues, nonetheless, need to be addressed. Existing programs and curricula need review and revision. While traditional courses remain relevant, the expertise in the Department could be used to develop novel streams or programs (like the Water Science model) that would appeal to students. Introductory GIS and remote sensing courses should be incorporated in the Earth Sciences undergraduate program. Many improvements depend on better collaboration with other departments (notably Geography). We do not see much merit in splitting the existing streams within the earth science degree into separate degree programs. Rather, changes to the University website would more easily enhance the desired visibility for the Earth Science program.

Current space is adequate but the Department cannot be expected to accept too many more undergraduate Majors and Minors without further provision of resources. Space rather than faculty and current teaching complement is the main limit to expansion.

We strongly recommend that the Department should hold a series of meetings or a retreat, attended by *all* faculty members and representatives of other groups (teaching staff and students should attend all discussions on curriculum and program development) during the next year to address these and other issues. The Department needs to demonstrate that it knows where it is heading, both in the short (next five years) and longer (five to ten years) term before it can reasonably expect to gain support from senior administration for any new initiatives, including replacement of retirees and new faculty hirings.



EXTERNAL REVIEW – ACTION PLAN

Section 1 – To be completed by the Responsible Unit Person e.g. Chair or Director

Unit under review	Date of Review Site visit	Responsible Unit person,	Faculty Dean
Department of Earth Sciences	March 9-11, 2011	James MacEachern, Chair	Claire Cupples

*Note: It is **not** expected that every recommendation made by the Review Team be covered by this Action Plan. The major thrusts of the Report should be identified and some consolidation of the recommendations may be possible while other recommendations of lesser importance may be excluded. Should an additional response from be warranted it should be attached as a separate document.*

1. PROGRAMMING

1.1 Action/s (description what is going to be done):

1.1.1 Undergraduate:

- **Curriculum.** The Review Team noted that, despite our general success at undergraduate education and high student satisfaction, our curriculum has recently become slightly out-of-date with reference to the educational requirements of APEGBC, the Provincial authority that governs the practice of engineering and geoscience in British Columbia. Specifically, the Provincial educational requirements have recently been modified to achieve alignment with the new National syllabus. The Review Team suggested that Earth Sciences undertake a complete review of its curriculum, from course content to scheduling and frequency of course offerings. **The Department of Earth Sciences agrees with the comments of the Review Team and will embark on a comprehensive review of the undergraduate program. We will redesign our curriculum to meet the new academic requirements and provide students with a solid foundation coupled with breadth and flexibility. Consideration of course scheduling and availability will be integrated with the new academic program. The educational requirements for both the Geology and Environmental Geoscience registration options of APEGBC will be mirrored by two of our academic Streams. Converting these Streams to Majors, as approved by the Department in 2010, will not be pursued without a thorough evaluation.**
- **Collaboration with other academic units.** The Review Team expressed strong interest in seeing the Department of Earth Sciences develop stronger programming ties with other academic units. It applauded our participation in the new Water Science program in the Faculty of Environment and recent progress toward a Joint Major with the Department of Chemistry. The Review Team noted that further collaborations are desirable, particularly with the Department of Geography. **The Department of Earth Sciences, in partnership with the Department of Chemistry, expects to seek University and Provincial approval for a Joint Major in the immediate future. The Department of Earth Sciences will continue to hold discussions with the Department of Geography on the subject of mutually beneficial curricular arrangements, and will explore the potential for joint programming with other academic units.**

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- **Student recruitment.** The Review Team noted that undergraduate enrollment in the Department of Earth Sciences is growing, but is still at modest levels. It suggested that the Department continue its outreach effort, and work with the Faculty and the University to enhance the visibility of Earth Science programming to attract additional students. In particular, it recommended that Earth Sciences 101 become a required component of the General Science degree program. **The Department will work with the Faculty and the University to raise the level of awareness of Earth Science programs, and will continue its outreach and recruitment activities. The Department recently voted to change the titles of its two most fundamental courses in order to attract greater numbers of students (pending approval, EASC 101 will change from *Physical Geology* to *Dynamic Earth* and EASC 210 will change from *Historical Geology* to *Evolving Earth*. The issue of converting program Streams to Majors will be examined in the context of program visibility and student recruitment (see information on *Curriculum*, above).**

1.1.2 Graduate:

- **Course work.** The Review Team recognized that graduate education in the Department is progressing well, and appreciated the challenge of providing graduate students with courses that are relevant, sufficiently specific and well populated. To address what it perceived as a tendency toward highly specific course topics and an absence of courses with broader applicability, the Review Team recommended that the Department consider mounting some team-taught courses with general topics such as “geochemistry.” **The Department will consider developing courses along the lines envisaged by the Review Team, i.e., “courses that would interest a broader cross-section of students.”**
- **Funding.** The Review Team noted the high cost of living in Metro Vancouver and suggested that the Department endeavour to raise the minimum yearly student earnings, possibly by paying graduate students a higher salary for work as Teaching Assistants, or by reducing the number of students it takes on. **The Department recognizes the challenge of providing adequate graduate student funding, which is derived from scholarships, teaching assistantships and faculty research (mainly NSERC) grants. Rates of pay for TAs are governed by a collective agreement over which the department has no control. Reducing the number of graduate students in Earth Sciences, in order to provide more TA opportunities for fewer students, is theoretically possible but is contrary to the expressed desire by the University to increase graduate enrollment, the increasing pressure from NSERC on faculty to develop larger graduate student research groups, and the NSERC-defined limits on the size of stipends payable from NSERC grants. In summary, action to increase student stipends will be discussed but may not be possible without additional investment in graduate student funding from the Faculty, University or Province. It should be noted that the Department’s guaranteed levels of student support currently equal or exceed the maximum levels specified by NSERC.**
- **Student environment and interaction.** The Review Team noted that some aspects of the overall student experience could be improved, including communication of administrative information and student supervision. It suggested greater flow of information, more consistent standards regarding annual evaluations, and enhanced interaction with guest speakers. **The Department will review its practices to ensure that the graduate environment is administratively fair and transparent. The criteria for scholarships are already widely disseminated; however, the department will create a section on the web-site for current students where all key information can be easily located. The guest seminar series will be maintained as a vehicle for**

student interaction, knowledge enhancement and professional growth.

1.2 Resource implications (if any):

The Department has limited financial resources to bring in guest lecturers and fund graduate students. If either of these areas becomes significantly expanded, funds will need to be diverted from our modest operating budget, or additional funds will need to be provided.

1.3 Expected completion date/s:

The Department of Earth Sciences expects all of the action items to be complete or well advanced by May, 2012. Outgrowths from some action items (for example the mounting of new undergraduate or graduate student courses) may require additional time to complete, and will be contingent on approval at higher administrative levels.

2. RESEARCH

2.1 Action/s (what is going to be done):

- ***Enhanced interaction.*** The Review Team noted that many of our faculty cooperate in research, but suggested that more interaction would be beneficial, especially for some of the smaller research groups. The reviewers also note that opportunities for collaboration with faculty in other departments and externally should be considered, and that research at the margins of existing disciplines as well as across disciplines is potentially beneficial. **The Department appreciates the comments of the Review Team and expects that Earth Sciences faculty will consider strengthening research ties with faculty in other academic units and with personnel in other universities and outside agencies.**

2.2 Resource implications (if any):

Additional research space will be required to permit Departmental growth, regardless of the areas of research.

2.3 Expected completion date/s:

The Department of Earth Sciences expects all of the action items to be complete or well advanced by May, 2012.

3. ADMINISTRATION

3.1 Action/s (what is going to be done):

- **Constitution.** The Review Team recommended a review and modernization of the departmental constitution. **The Department will undertake a review of its constitution and other relevant documents such as tenure and promotion criteria.**
- **Policies, procedures, communication.** The Review Team expressed concern that there may not have been enough departmental meetings and time for discussion over the past several years. It recommends greater participation of faculty at departmental meetings and stronger adherence to departmental policies and procedures, and respect for the constitution. **The Department will ensure that there are sufficient department meetings to discuss the many issues defined in the review document in addition to the normal maintenance and upkeep of the Department.**

3.2 Resource implications (if any):

None.

3.3 Expected completion date/s:

The Department will revise its constitution by May, 2012, and will encourage discussion and communication on an ongoing basis.

4. WORKING ENVIRONMENT

4.1 Action/s(what is going to be done) :

- **Space.** The Review Team noted that with the expected growth of Earth Sciences, instructional space will become an increasing concern. To alleviate this problem, it suggested that an additional, nearby room be transferred to Earth Sciences. The Review Team also recommended that our Department endeavour to share a seminar room with Computing Science. It also recommended that Earth Sciences procure space for discussion and collaboration among graduate students and faculty. **The Department of Earth Sciences recognizes that instructional space is fast becoming an issue, and that increased lab sections are causing congestion in our labs. A specific, nearby room in TASC-1, which is seldom used by the current occupants, would serve to alleviate the need currently faced by the department for additional instructional space. Additionally, EASC would benefit greatly from a formal sharing arrangement of a seminar room in TASC-1 with another department. Procuring a room for coffee and discussion would also benefit the department, and we suggest that the carpeted foyer that lies between our banks of offices (adjacent to our meeting room, 7401), should be enclosed (while preserving public access to the adjoining doorway) and transferred to Earth Sciences. The Department is willing to work with the Dean of Science and other elements in the university to bring about changes to its space situation, but realizes that such arrangements would likely need to be implemented at the level of the Vice Presidents.**

• **Equipment.** The Review Team recognized the Department's need for a new bus and additional petrographic microscopes in the near future. Both items will cost tens of thousands of dollars; these amounts are presently well beyond the levels of discretionary spending in the Department's annual operating budget. The Review Team recognized that private funding may be obtainable, particularly for the bus. **The Department concurs with the Review Team that a new bus and new microscopes will soon be needed. The Department will monitor the situation and place a request for funding with the Dean of Science, hopefully before the situation becomes critical. The bus is currently in working order but requires repair with increasing frequency. It is beginning to burn more oil than is generally considered acceptable. The Department will explore the possibility of obtaining private funding to augment University funding.**

4.2 **Resource implications (if any):**

Additional space will be needed to meet the increasing demands of teaching and research. Replacing the bus and purchasing new microscopes will cost as much as \$200,000.

4.3 **Expected completion date/s:**

The issues of space and equipment will be reviewed. We will keep the Dean of Science apprised of the bus's condition, our microscope needs, and the prospect of private donations.

5. Planning Exercises

5.1 **Action/s:**

- **Strategic Plan.** The reviewers identified a need for a strategic plan that would include a discussion of research directions and future academic hiring. **A departmental Strategic Plan will be developed in concert with three main exercises: revision of the undergraduate curriculum, enhanced collaboration with other academic units and agencies, and adjustment of the departmental constitution. The plan will articulate a vision for the next several years and serve as a foundation for the next departmental three year plan (due in 2012). The Strategic Plan will establish future research directions and hiring priorities. It will also provide a clear view of how Earth Sciences will continue to serve the needs of students, contribute to the academy, and link effectively with the broader community.**


5.2 **Resource implications(if any):**

Development of the Strategic Plan, and the items from which it derives, will require extensive discussion with the entire department. The process would be facilitated by a series of half-day or full-day planning events, one or more of which could take the form of a retreat.

5.3 Expected completion date/s:

The Strategic Plan will be the culmination of discussions and decisions made in the areas of teaching, research and administration, and will be finalized toward the end of the Action Plan interval. Issues regarding the undergraduate curriculum will be initially dealt with by the departmental Undergraduate Curriculum Committee in the Fall Semester of 2011, and then brought to the department for further input. Discussions regarding research directions and hiring priorities will likely commence at special departmental meetings in the Fall Semester of 2011 and extend into the Spring Semester of 2012. The outputs from these exercises and other discussions will be shaped into a comprehensive Strategic Plan late in the Spring Semester of 2012.

The above action plan has been considered by the Unit under review and has been discussed and agreed to by the Dean.

<p>Unit Leader (signed) </p> <p>Name <u>JAMES MacEACHERN</u> Title <u>Professor + Chair</u></p>	<p>Date <u>Sept 08, 2011</u></p>
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Section 2 - Dean's comments and endorsement of the Action Plan :

The Department of Earth Sciences is to be congratulated on the very positive nature of the External Review and on their well-developed Action Plan. This process comes at an opportune time since it aligns with many of the planning initiatives that we are starting to set in motion in the Faculty of Science, specifically:

- examination of curriculum at both the undergraduate and graduate levels;
- reassessment of undergraduate degree programs;
- development of fiscally-sustainable faculty and staff hiring plans;
- development of a workable space plan;
- analysis of optimal graduate student numbers (in light of changes at NSERC, the end of BC government build out of graduate student numbers, and a cost-benefit analysis of TAs);
- examination of how to preserve, prioritize and augment non-salary operating budgets in the face of anticipated university budget stasis in the coming decade.

Many of the solutions that we develop as a Faculty will be informed by, and will inform, the Earth Sciences Action Plan outlined here. However, I recognize that the Department of Earth Sciences has special needs. In particular, it has the challenge of recruiting undergraduate students given the lack of exposure to this discipline at the high school level. I and my staff will be happy to assist the department in its recruitment and retention efforts.

As acknowledged in the departmental Action Plan, several items will require or will be facilitated by decanal level discussions. I will work with my colleague in the Faculty of Environment to encourage productive interactions between Earth Sciences and Geography on the subject of undergraduate curriculum development and revision. I will discuss the space needs of Earth Sciences (specifically TASC1 7000) with my colleague in Applied Sciences. I have already started discussions with the Dean of Graduate Studies on the matter of graduate student numbers and graduate student funding.

I strongly endorse the recommendation that the department develop a strategic plan and, indeed, I will be expecting the other seven departments in the faculty to develop their own plans and participate in development of a strategic plan for the Faculty. Allocation of resources should always be contingent on well-developed plans.

Faculty Dean



Date

