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MEMORANDUM

ATTENTION: Senate

TEL

FROM: Peter Keller, Vice-President, Academic and Provost, and Chair, SCUP

A handwritten signature in black ink, appearing to be "Peter Keller".

RE: External Review of the Department of Chemistry (SCUP 16-32)

DATE: October 17, 2016

TIME

At its September 21, 2016 meeting, SCUP reviewed and approved the Action Plan for the Department of Chemistry that resulted from its external review.

The Educational Goals Assessment Plan was reviewed and is attached for the information of Senate.

Motion:

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

c: S. Holdcroft
C. Cupples

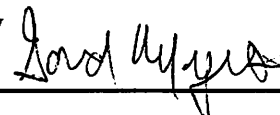
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MEMORANDUM

ATTENTION Peter Keller, Chair, SCUP **DATE** September 7, 2016
FROM Gord Myers, Vice-Provost and **PAGES** 1/1
Associate Vice-President, Academic
RE: Faculty of Science: External Review of the Department of Chemistry



Attached are the External Review Report and the Action Plan for the Department of Chemistry. The Educational Goals Assessment Plan is included, for information only, with the Action Plan.

Excerpt from the External Review Report:

"The SFU Department of Chemistry is an excellent unit, with some of the top researchers in the country, and an admirable depth of expertise in focused areas."

Following the site visit, the Report of the External Review Team* for the Department of Chemistry was submitted in May 2016. The Reviewers made a number of recommendations based on the Terms of Reference that were provided to them. Subsequently, a meeting was held with the Dean of the Faculty of Science, the Chair of the Department of Chemistry and the Director of Academic Planning and Quality Assurance (VPA) to consider the recommendations. An Action Plan was prepared taking into consideration the discussion at the meeting and the External Review Report. The Action Plan has been endorsed by the Department and the Dean.

Motion:

That SCUP approve and recommend to Senate the Action Plan for the Department of Chemistry that resulted from its external review.

***External Review Team:**

Rob Lipson, University of Victoria (Chair of Review Team)
David Palmer, University of Saskatchewan
Elsa Reichmanis, Georgia Institute of Technology
Dan Marshall (internal), Simon Fraser University

Attachments:

1. External Review Report (May 2016)
2. Department of Chemistry Action Plan
3. Department of Chemistry Educational Goals Assessment Plan

cc Claire Cupples, Dean, Faculty of Science
Steven Holdcroft, Chair, Department of Chemistry

**EXTERNAL REVIEW REPORT
DEPARTMENT OF CHEMISTRY – SIMON FRASER UNIVERSITY**

On-Site Visit Dates

March 30th - April 1st, 2016

Review Committee

Rob Lipson (Chair) – Department of Chemistry, University of Victoria

David Palmer – Department of Chemistry, University of Saskatchewan

Elsa Reichmanis – Department of Chemistry and Biochemistry, Georgia Institute of Technology

Dan Marshall (Internal Consultant) – Department of Earth Sciences, Simon Fraser University

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Executive Summary and list of recommendations

The SFU Department of Chemistry is an excellent unit, with some of the top researchers in the country, and an admirable depth of expertise in focused areas. The department is at this time space-constrained, and therefore must focus on making the best use of its available space and resources. Its undergraduate education is appropriate, balanced and effective, but the physical/analytical instrumentation must be replaced at the earliest opportunity. There is an opportunity to accomplish this moving the Centre for Self-Directed Studies initiative forward. In addition, opportunities within the programs to enhance student communication and writing skills should be reviewed. Innovative ideas like 1-credit-unit courses and industry-engaged laboratory instruction should be strongly supported by the Faculty of Science and the Central Administration. Graduate student education is modern and productive, with outstanding training opportunities provided by the 4D Labs and the nascent high-throughput screening facility. The department should seriously consider increasing the graduate student stipend to be competitive with other universities and in recognition of the expensive Vancouver market. The department's staff is engaged and well-treated, but is currently understaffed in the area of financial services. The unit should consider how to use their existing resources to meet their administrative needs. The department's faculty has created a collegial atmosphere, but gender equity needs to be pursued with determination, along with a more systematic level of mentorship for junior faculty.

The following list of recommendations are expanded upon within the report:

1. We strongly urge the department to strike a committee to consider how their space allocation could be better optimized to meet their current needs, and those going forward.
2. Despite the magnitude of the problem and the costs, the time for action to replace the equipment in the undergraduate Physical/Analytical Laboratories is now. Students are simply not being trained adequately in the use of modern analytical instrumentation to be competitive for employment after graduation.
3. Develop a succession plan to replace the Director of LON-CAPA.
4. We recommend that the university establish a pool of money for minor equipment that Faculties can compete for annually.
5. We recommend that the department explore whether some of the first-year course offerings can be rationalized to reduce the associated teaching commitment, especially as some of these courses are offered in all 3 semesters.
6. We urge the university to support Chemistry's innovative approach of developing 1-unit course modules.

7. We recommend that, depending on the funding available, Phase 1 for establishing the Centre for Self-Directed Studies be done if needed in several steps, and perhaps over several years.
8. We recommend that the department ensure that all students have the opportunity to enhance their communications skills (written and oral), and that they receive timely feedback in this regard.
9. We urge the department, if they have not done so already, to be more proactive in mentoring their junior faculty with respect to their NSERC grant submissions.
10. We strongly support the development of modular courses at the graduate level. Effort should be made to identify topics and instructors, and to schedule the modules at least one year in advance so that students can plan accordingly.
11. We encourage Chemistry to re-examine their graduate student stipend offers.
12. We urge the Central Administration to reinstate the previous funding model to assist the Faculty of Science in managing its programs.
13. We strongly support the hiring of talented female faculty members and the use of a targeted search, if possible, in this regard.
14. We suggest that staff evaluations be done on a biennial basis.
15. We strongly recommend that a succession plan for a new glassblower be devised now.
16. We recommend that the department explore the idea of creating internal department guidelines for the tenure and promotion committee, increasing the SFU requirement of 1 female committee member to 2 provided that this is consistent with the compositional expectations of the Collective Agreement. If it is, we suggest having 2 female research faculty on the committee for tenure and promotion of research faculty, and one female research faculty and one teaching faculty for decisions concerning teaching faculty.
17. We recommend that the Dean consider striking an Equity and Diversity Committee at the Faculty level.
18. We suggest a small manual be prepared for incoming faculty outlining processes and procedures. The department perhaps could be more proactive in assigning a specific mentor to help integrate each new colleague. This might be accomplished by establishing a mentorship committee.
19. We suggest that misunderstandings around space and/or immigration in particular can be eliminated by moving away from verbal commitments to ensuring they are actually written into the Letters of Offer.
20. We recommend that new faculty begin their appointments on July 1st, if possible.
21. We suggest that the unit consider better integrating their adjuncts especially those associated with the Nuclear Chemistry group to support the teaching and research activities in that theme area.

Overview

During the site visit the review committee met with the senior leadership from the Central Administration, the Dean of Science, the Chair of Chemistry, and representatives of the department for the faculty, staff, undergraduate and graduate students. We were given a tour of the facilities in the department and related areas on campus such as the 4D Labs. Although we did not visit the Surrey campus, the faculty who teach there on a regular basis provided us with their impressions. We asked and received frank and candid opinions on a variety of departmental and university issues, and when appropriate, we probed the specific issues provided in the Terms of Reference. In addition we noted other concerns and issues that emerged from individuals and groups who asked to be part of the scheduled agenda.

One interesting question posed to the review committee at the final debrief with the senior administrators was whether we felt that the Department of Chemistry could be ranked in the top 5 in Canada. Rankings are often subjective and far from clear cut because they can change dramatically depending on the criteria used to establish them. Overall, we suggested that SFU Chemistry might be listed in the top 10 from across the country. The reason for this is that there are other larger more comprehensive research-intensive Chemistry departments in Canada. That said, SFU Chemistry has been very strategic over the years in developing specific areas of research which already distinguish it from the pack, and in those fields, the unit may indeed be top 5. It has a strong reputation both nationally and internationally in chemical biology, materials science and nuclear chemistry. If particular initiatives such as the Canada First Research Excellence Fund (CFREF) application around hydrogen fuel cells is successful, the department will be well positioned to become truly global. The Associate Vice President Research indicated that Chemistry is seen as a leader in the Faculty of Science for engaging and obtaining funding from industry. Overall, we feel confident in stating that SFU Chemistry is an excellent unit, and one of which the Faculty of Science and the university as a whole can be very proud of.

In this report we provide our observations and suggestions under the general headings of 1) Infrastructure, 2) Undergraduate Program, 3) Graduate Program, 4) Faculty and Staff, and 5) Other Issues. Within these sections we strive to address the impact on the departments' academic programs and research profile.

Committee Observations and Recommendations

1. Infrastructure

Between 2009 and 2013, the Department of Chemistry underwent two phases of renovation leading to state-of-the-art teaching and research space. The latest renovations upgraded the Analytical/Physical Teaching Laboratories, provided additional faculty offices, and built the Trottier Studio for Innovative Science Education (not visited). We heard many times how appreciative the unit was for these renovations which indeed has made the space very attractive, and most importantly, safer. At the same time, we also heard several times that because essentially no new space was created, there remains little opportunity for research growth. Currently graduate students are being squeezed in as best as possible. The issue with space is also evident in that some new major equipment like a Raman microscope obtained through successful CFI applications is being housed in the undergraduate labs in the absence of additional research space. To the best of our knowledge the only new space (although not belonging to Chemistry) which is being provided by the Dean of Science is a classroom which will be repurposed as a High-Throughput Screening Facility (HTSF). The Faculty of Science has also made a 3-year commitment to support a technician for the HTSF. Unfortunately, we foresee problems down the road for maintaining the position through outside contracts as we were told the biotech industry is thin in the Vancouver area.

Using entitlements in Net Assignable Square Meters calculated according to the B.C. Universities Space Manual is not a particularly useful argument because those metrics are at best underestimations.

We cannot at this time argue that new Chemistry space should be the highest priority of the Faculty of Sciences given that other units have space that needs drastic remediation. However, this does not mean that space is no longer an issue for Chemistry despite the renovations. If there are new appointments in the near future, and/or if the current younger faculty members are to grow their groups, and/or if research initiatives such the CFREF application are successful, then space will become a pressing concern.

Recommendation #1: We strongly urge the department to strike a committee to consider how their space allocation could be better optimized to meet their current needs, and those going forward.

The issue of the 4D Labs is complex. This impressive open-access research facility was originally funded by a CFI proposal put forward by SFU Chemistry. The Executive Director and other leadership positions fronting various materials theme areas within

the 4D Labs are chemists. Chemistry also clearly benefits in that 6 of the 8 research labs on the upper floor are used by departmental faculty members, as well as the office space which houses their graduate students. Thus one could argue that this appears to be *de facto* Chemistry space. However, the 4D Labs have now grown in size and impact to become a Centre under the auspices of the Vice President Research. Furthermore, there are many internal and external (academic and industrial) users who are not members of the Chemistry department.

We conclude that while earlier on it would have been easier to state that the facility is Chemistry space, this is no longer the case. Instead, a better perspective is that Chemistry's dominant presence in the 4D Labs is attributed to its scientific prowess in materials science, and its success in growing the facility, mainly through CFI initiatives such as the Prometheus Project.

The largest gap with the Chemistry department remains the instrumentation in the Physical/Analytical Teaching Laboratories, which is at best antiquated. We were amused when told that many students have asked what the 5¼ inch floppy drives on some of the associated computers were; having never seen them before. Indeed when talking to the undergraduate student representatives, the first thing they said about their experience in the physical/analytical lab courses is that the equipment continually breaks. The last review report in 2008 identified the need for new instrumentation as “the department’s most urgent need”, and wrote that it was a “sad irony” that the “the SFU Department of Chemistry has some of the best instrumental facilities for research in the world and yet the undergraduates have access to only badly outdated, failing and broken equipment, when it is available at all”. We strongly agree. It is disappointing that the same situation remains in 2016. Although the department did receive \$400K to upgrade these laboratories following the last review, it is clear that a proper revamp will require several millions of dollars.

Recommendation #2: Despite the magnitude of the problem and the costs, the time for action to replace the equipment in the undergraduate Physical/Analytical Laboratories is now. Students are simply not being trained adequately in the use of modern analytical instrumentation to be competitive for employment after graduation.

2. Undergraduate Program

The undergraduate program at SFU for Chemistry Majors provides the traditional coverage of topics in organic, inorganic, physical and analytical chemistry, with the associated lab components. In addition, students take a variety of mathematics, physics, and biochemistry courses. Approximately 1/3 of the students participate in Co-op. Overall, the program meets the requirement for accreditation by the Canadian

Society for Chemistry (CSC). Sufficient courses are also given that allow students to meet the SFU writing requirement. That said, the last review in 2008 noted that coverage in main group chemistry was cursory. That still seems to be the case in that this topic appears to be only covered in CHEM 230. The last review also noted a limited exposure to kinetics but this seems to have been rectified based on the calendar description for CHEM 360.

Students can graduate with an Honours designation if they complete a significantly larger number of upper division units. We were told that only ~10% of the students graduate with this designation. This suggests that students may perceive the requirements for Honours to be too onerous relative to the benefits the credential confers.

The department has wisely increased its minimum GPA standard for continuance in the Chemistry Majors program from 2.0 to 2.2 which has led to an increase in the quality of the students in the program. While the number of direct entry students into Chemistry has gone down, this change has not dramatically affected the number of majors who ultimately end up in the program. Student numbers are of course important, but so too are the numbers of students who graduate. This metric can only improve when the quality of the students is higher.

We heard no specific concerns about the faculty teaching loads in absolute terms. However, several members have reduced or no teaching role due to internal or external administrative responsibilities. Furthermore 3 are on medical leave. Overall, this has put pressure on the department's ability to mount their programs. Not surprisingly as a result, the department would like to hire more faculty but are constrained by a paucity of available research space to do so.

First year Chemistry enjoys high enrolments both at the Burnaby and Surrey campuses. Lecturers teaching at the Surrey campus find the classrooms and facilities there to be excellent. The only comment heard about the curriculum was that it may be time to consider developing new experiments in the first year labs. The department is well served by the LON-CAPA on-line learning tools which was pioneered by a dedicated Senior Lecturer, Dr. Batchelor, and now is maintained by lecturers with the help of IT support. This software can provide customized assignments and on-line practice questions for each student. We are concerned however that this resource depends almost entirely on one individual who may be considering retirement sooner than later.

Recommendation #3: Develop a succession plan to replace the Director of LON-CAPA.

The laboratory staff also conveyed a worry about the state of the equipment in the first year labs. Basic pieces like hot plates and balances are so heavily used that they are better viewed as consumables than equipment. There does not appear to be a formal annual mechanism to fund replacement pieces as they wear out. Although Chemistry does have a non-salary operating budget (~\$300K) which could in principle be used to purchase minor equipment, the total dollar amount is in reality very small given the diversity of teaching and research activities taking place within the unit that require support. Faced with similar situations, other institutions have set aside an annual budget for minor equipment that Deans can compete for, and subsequently allocate to units as needed.

Recommendation #4: We recommend that the university establish a pool of money for minor equipment that Faculties can compete for annually. It isn't sexy but in the end the minor equipment purchased through such a process would be used by very large numbers of students, and thus would have a positive impact on many programs.

We were struck by the number of first year courses in the calendar; some which are geared to students with no prior Chemistry background, another which is aimed at students who have fully mastered high school chemistry, and yet others which are offered as breadth requirements. One first-year course, CHEM 109, is restricted to students in the Aboriginal pre-health program. This strikes us as a larger than normal number of first-year offerings.

Recommendation #5: We recommend that the department explore whether some of the first-year course offerings can be rationalized to reduce the associated teaching commitment, especially as some of these courses are offered in all 3 semesters.

We did not perceive any major issues with the **second and third year courses**. The last review stated that the faculty were supportive of a course in group theory and symmetry. This does not appear to have been developed although as noted before, such a course is not offered at every institution.

In **fourth year** a variety of research opportunities and courses are offered which have some alignment with the research activities in the department. It is encouraging that nearly 50% of the class take CHEM 484 – Two-Semester Undergraduate Research in Chemistry. We were told that two-semester courses are counter to the SFU tradition, but this, in our opinion, is definitely a worthwhile exception.

Joint Programs: The department offers several joint Major and Honours programs with Earth Sciences and with Molecular Biology and Biochemistry (MBB). There is also a Chemical Physics program. We were told that the quality of the students enrolled in the joint CHEM/MBB program was particularly good. Approximately 45% of the students enrolled in the joint programs participate in Co-op.

The department also offers Minors in Chemistry, Environmental Chemistry, and in Nuclear Science. The latter is relatively unique and capitalizes well on SFU's long-standing association with TRIUMF. The enrolments in the Minor programs are reasonably healthy.

New program themes: The department is aligning its research activities around 3 major themes: Materials Chemistry, Chemical & Structural Biology, and Nuclear Science. We met with representatives from each theme group. It was generally acknowledged that the undergraduate curriculum does not strongly support the first two themes given the desire to maintain CSC accreditation.

One initiative being considered in Chemical & Structural Biology is to offer 1 unit (~4 week) modular courses. The teaching could then be more easily distributed among the faculty, even those with reduced teaching loads. The course content could also be better tailored to the expertise of the instructor which will make the prospect of teaching the modules more attractive. To avoid duplication of material the department proposes to offer one foundational module upon which others can build.

The Materials Chemistry group is also considering offering 1 month modules and to pilot a series of team-taught 13 week (3 unit) courses; in essence a "modules-within-a course" structure. It is envisaged that some students will be selected to shadow researchers in their labs including the 4D Labs facility as one possible type of experiential module.

Of concern to us is the departmental perception that the university is putting up obstacles for units wishing to develop 1-month long modular courses. Specifically, Chemistry appears to be receiving conflicting information from the Registrar and the Senate Committee on University Priorities (SCUP) in this regard.

Recommendation #6: We support the development of 1-unit modules strongly. We urge the university to support Chemistry's innovative approach to curriculum development as the students will be the big winners by having a robust slate of courses from which to choose. Additionally, faculty expertise can be more efficiently concentrated and tailored to student demand.

An intriguing and ambitious proposal coming out of Chemistry and being championed by one faculty member is the establishment of The Centre for Self-Directed Studies. The idea is that SFU will partner with Industry to obtain state-of-the-art analytical instrumentation that can provide many industry-inspired laboratory experiences that can run simultaneously. The intent is to create 90 new labs which students can choose from depending on their interests. At the same time, the labs would be a showcase for the Industry vendors to exhibit their instrumentation in action. The investment would be in the several millions of dollars. The scope of the Centre is such that many other units in Science and beyond will benefit. This is an exciting proposal in part because it solves Chemistry's most pressing issue; namely replacing the antiquated instrumentation in the Physical/Analytical Labs (see recommendation #2).

Several years ago the University provided ~\$700K in funding to match the contributions from Industry. However, the money was not used in a timely fashion and was subsequently and understandably repurposed elsewhere. It is never a good idea to leave money on the table. From our perspective, the strategic mistake appears to be aiming to secure the financial commitments to "fully" realize the vision for the Centre.

Recommendation #7: We recommend that depending on the funding available Phase 1 for establishing the Centre for Self-Directed Studies be done if needed in several steps, and perhaps over several years. Reequipping the lab in part is much better than continuing on only with the existing instrumentation. While we commend the faculty member for his vision and drive, it is now time for the department and in particular the Chair to also work with the Dean of Science and the upper administration to move this initiative forward. It has the potential to distinguish SFU from other institutions not only in terms of student access to state-of-the-art instrumentation, but in innovative custom programming depending on the interests of the students.

Undergraduate Student Experience: We enjoyed our interactions with the undergraduate student representatives who struck us as very engaged with their studies and with the department. Overall, they indicated their satisfaction with the program, and recognized and appreciated the departmental strengths in research and teaching. They found the faculty engaged and approachable.

Nevertheless, they identified several issues which they felt needed addressing:

- As noted above the students found the instrumentation in the Physical/Analytical labs is problematic.

- They were concerned about the writing components of the courses they took. Specifically they felt unprepared to write a good cover letter or a journal article.
- Related to the last point, those students with Co-op experience found that the expectations of Industry around writing differ from that within the university; that the writing done in their courses is too academic and not as useful in the real world.
- The students were concerned that courses concentrating on oral presentations (CHEM 481, 483, 484) were not mandatory for everyone. They suggested a communications skills course in the 2nd year and a course specifically dealing with research proposals in the 3rd or 4th year would be useful for every Science student regardless of their program.
- The students were particularly unhappy about CHEM 366W. Specifically they did not receive timely feedback on their writing. Hence they repeated many errors which could have been averted if the TAs were returning their submissions more promptly. In some cases the students received only an overall mark. Furthermore, the marking was perceived to be inconsistent from TA to TA.

It should be noted that similar complaints were voiced in the 2008 review although not specifically around CHEM 366W. Although one cannot satisfy every student, at this time when learning outcomes are becoming key metrics in course and program assessments, faculty have to not only set out expectations for their students but also for their TAs. Clearly grad students are busy both with coursework and research. However, time management is a valuable skill. Faculty must take ownership for what happens in the lab, and ensure that the every student is receiving timely feedback. This oversight will be particularly important for TAs involved with the proposed 1-unit course modules.

It was also noted many of the best lab TAs are converted to lecture TAs. We do not know whether this has a bearing on the issues raised for CHEM 366W. However, common sense suggests that the better TAs should be in courses that fulfill the writing requirements of the programs.

- We note that two of the students we met with indicated that they were most interested in Environmental Chemistry. Although the department does offer an Environmental Chemistry Minor, we do wonder if more students would pursue Chemistry at SFU if the Majors and Honors programs had more of an emphasis on environmental issues. We recognize however that environmental chemistry is not an area of research strength in the unit.

Recommendation #8: It is out of scope to recommend Science level communications and writing courses. This has to be decided by the Dean of Science in consultation with all the Science units. However, it is clear that students are very keen to not just

learn Chemistry but to also acquire the “soft-skills” that make can them competitive after they graduate. We recommend that the department be sensitive to these aspirations and ensure that all students have the opportunity to enhance their communications skills (written and oral), and that they receive timely feedback in this regard.

3. Graduate Program

There is no question the Chemistry Graduate program meets high-internationally-recognized standards of scholarship. This is borne out by the quality and number of high-impact papers the research faculty publishes annually, their research funding success, and the awards and distinctions the faculty and graduate students have received. As shown in Fig. 5.10 of the Self-Study Chemistry brought in more funding than any other Science unit in 2014/15. Between 2012 and 2015 Chemistry’s funding constitutes ~25-30% of the total brought in by the Faculty of Science. The undergraduate students appear to appreciate the quality of the graduate program as well in that many of them stay with SFU Chemistry for their graduate studies.

It was pointed out by the Dean of Science that Chemistry actually has the lowest success rate in the Faculty with respect to NSERC Discovery Grants, and their overall funding level is attributed to large successful CFI grants. She indicated that a worrisome gap has developed in Chemistry between the stars and the rest. We acknowledge and share this concern but also recognize that there could be reasons at this time for this situation. First there is an abnormally large number of faculty on extended sick leave. Another has left to become President of NSERC. Second, Chemistry is one of the most selective disciplines when it comes to funding Discovery Grants. The success rates as a result tend to be lower but the dollar amount per successful grant, higher. We feel Chemistry should actually be commended for their CFI success and for the diversity of funding agencies accessed (as shown in Fig. 5.7 of the Self-Study). NSERC considers a Discovery Grant to be a seed grant. Chemistry is doing what it should; namely, leveraging their NSERC success to procure other sources of funding.

Where we are more concerned is about the newer faculty members. Often a lack of success at NSERC for early career faculty can be ameliorated if the unit is more proactive in the area of mentorship. One model which can work is to assemble a group of more senior researchers who have served on NSERC Evaluation Groups to read drafts of Discovery Grants well in advance of the submission date. They should be prepared to provide hard but constructive criticisms based on their collective experience around the NSERC table. In turn, applicants should be prepared to heed the advice given very carefully because good grantsmanship and good science are really not the same thing.

Recommendation #9: We urge the department, if they have not done so already, to be more proactive in mentoring their junior faculty with respect to their NSERC grant submissions. The model proposed above to vet proposals can also help more established researchers.

The Chemistry graduate program has grown from 50 students in 2001 to 120 students in 2007. The graduate student population has stabilized for the most part around the 120 mark. The department is also home to ~ 20 post docs. These are very healthy numbers and can be reasonably attributed in part to excellent new faculty hires and overall departmental funding success. Given that SFU competes for students with UBC, it also would not be unreasonable to attribute in part the large graduate population to the research foci developed in the Department of Chemistry over the years. The central administration expressed some concerns over what they saw as a large post-doc cohort in the unit. While this issue was not a strong focus during the site visit, overall, we do not see this number as worrisome. Why a post-doc would remain for a long time in such a position probably depends very much on each individual. It could very well be related to the academic and industrial job market. The majority of students work within the Materials Chemistry and the Chemical & Structural Biology theme groups. The number of students gravitating towards Nuclear Chemistry is relatively small. This will probably always be the case because Nuclear Chemistry is a niche physical chemistry area (although one which SFU benefits from), and perhaps in part because the culture of BC is such that local students are often more attracted to fields that are perceived to be environmentally-friendly. Given that the federal government has continued to provide direct funding to TRIUMF, and the current renaissance in radiochemistry applied to PET imaging, there is an opportunity to enhance this area of focus in collaboration with Chemical Biology.

The Dean of the Graduate Studies (DGS) indicated that most Chemistry M.Sc. candidates enter the Ph.D. stream and most Ph.Ds. take up post-docs. This suggests that most graduate students are on an academic track. On the other hand, while one of the students we met from the Graduate Student Caucus was certainly interested in academia the others were more interested in landing a job in Industry.

While a majority of the graduate students surveyed were "*very satisfied*" with the guidance they receive from their supervisors we were very concerned to read that 15% of those students surveyed are very or somewhat dissatisfied with their supervisor, and 17% are dissatisfied with their experience in general. The Dean of the FGS indicated that this consistent dissatisfaction with the Chemistry graduate program is not related specifically to the student supervisors as much as it reflect a desire by the graduate students to receive more professional training and career development than

they are currently getting. This suggests that more and more graduate students are looking at options other than academia after graduation. The Department should be sensitive to this shift in their graduate programming.

One issue that persists from the last review and was again articulated in our meeting with the Graduate Student Caucus is the number, quality, variety and availability of the graduate courses offerings. This concern is consistent with surveys that show that 33% of students are somewhat or very dissatisfied with course availability. The students indicated that finding relevant courses of interest for their research areas within a given semester was very challenging and as a result, not conducive to timely graduation. Indeed the average tabulated times to completion for M.Sc. candidates in particular as listed in Table 7.2 of the Self-Study are overly long.

Since most of the graduate courses are cross-listed with senior level courses, the choices for students entering graduate school at SFU from the SFU undergraduate programs are hard-pressed to find new courses to take. We were told that graduate students can re-take an undergraduate course at the graduate level provided the course content has changed a lot. However, this would depend on the instructor, and therefore, could not be guaranteed.

The department is proposing to develop a series of modules similar to that described at the undergraduate level. Each would be a standalone 1 credit (~4 week) unit concentrating on a selected topic. The intent is to have ~12 modules per semester. Again, recognizing that many modules could potentially share substantial background knowledge, the department will develop a 1-unit core course that will provide the foundation for the other modules.

Recommendation #10: We strongly support the development of modular courses at the graduate level. It will increase the availability of courses per semester which are of interest to the graduate students, allow more faculty to participate in graduate instruction, and reduce the times to graduation. Effort should be made to identify topics and instructors, and to schedule the modules at least one year in advance so that students can plan accordingly. For obvious reasons any foundational modules should be offered annually.

The graduate students presented us with a list of other concerns:

- They feel that the required courses CHEM 801 (Student Seminar), CHEM 802 (M.Sc. Research Proposal and Examination) and CHEM 808 (Ph.D. Candidacy Examination) do not have clear and consistent requirements or outcomes that are independent of the instructors.

- They feel the standard of submitting their Ph.D. thesis 10 weeks in advance is too long because it forces them to enroll and pay tuition for an extra semester. We were told however by the Departmental Graduate Studies Committee that the 10 weeks is more of a guideline, and that the department makes every effort to accommodate shorter times if possible. They also indicated that students continue to receive RA funding during the “extra” term, and that the fees they are required to pay are 25% of what they pay in their first year.
- They feel there was not nearly enough Faculty of Science or University-level travel support to attend conferences.
- They feel their annual stipend is low both relative to other Science units, and to nearby institutions such as the University of Alberta, the University of Victoria, and the University of British Columbia. They note that the stipend has not been raised in 5 years although the graduate tuition has increased by 10%. Lastly Vancouver is a relatively expensive place to live.

The Dean of Graduate Studies informed us that the Chemistry stipend is 3rd in value at SFU behind Kinesiology and Physics. The department informed us that they are considering examining the stipends they give to their graduate students.

Recommendation #11: We encourage Chemistry to re-examine their graduate student stipend offers. While one would hope that the better students are looking more at the research than the stipend, it is a disincentive to come to an expensive city like Vancouver to live if the SFU stipends being offered are not competitive with other Chemistry departments.

4. Faculty and Staff

Research Faculty: As noted above, the Chemistry department has aligned their research “brand” around three theme areas: Materials Chemistry, Chemical & Structural Biology, and Nuclear Science. Membership within any of these groups is based on self-identification.

The Nuclear Science group is small (2 researchers). There is a third faculty member who has a good fit with this theme but considers himself first and foremost, a physical chemist.

The Materials Chemistry group appears to be quite cohesive. There are many sub-group collaborations which have been enhanced by the establishment of the 4D Labs and the National Research Network in Catalyst Research for Polymer Electrolyte Fuel Cells. SFU’s and Chemistry’s prowess in hydrogen fuel cells is recognized by the university in that this activity is the subject of a CFREF application in the latest round.

We learned that Mercedes has already located facilities for fuel cells in Surrey and established strong interactions with researchers in Chemistry and other units at SFU. The economic benefits for the community going forward could be profound.

Collaboration within the Chemical & Structural Biology group does take place, but by their own admission, there is no over-arching vision as yet seeding new interactions. The new HTSF may act as the nucleus for developing a strategic vision for this group.

We explored the inclusiveness of these theme groups. It is clear that they reflect the evolution of the department over the years especially with respect to faculty appointments. It is also clear that the decision to align their activities in this way has come out of robust discussions within the unit.

We conclude that while there may be a few individuals who do not see themselves within the themes, or choose not to identify themselves in this way, the theme areas are for the most part inclusive and supported by the department.

The Nuclear Chemistry group is small and so it is natural to wonder if growing this area is seen as an urgent priority. The Chair identified 3 priority areas for new faculty hires which in ranked order are: Electrochemical Surface Science, Chemical Neurobiology, and Nuclear Medicine. Of course depending on the research expertise of a new hire in Nuclear Medicine there could be considerable synergy with the Chemical Biology group. Based on this list, the Nuclear Chemistry group will probably not have the opportunity to grow in the near future (although the department acknowledges a new hire in this field is desirable) especially given the budgetary constraints at SFU caused by the reduction of the weighted funding per Science student by a factor of 2. However, opportunities appear to exist to integrate adjunct faculty members at TRIUMF better within the department. This will be discussed further in Section 5.

The reduction in the budget weighting for Science students strikes us as very problematic. While a higher weighting may on the surface appear to be unfair for example to the Arts and areas of the Social Sciences, the reality is the cost to educate Science students is higher than other areas of the Academy, based mainly on the costs of the experiential components of most of the programs. Eliminating the experiential components because of costs is simply pedagogically unsound and would render the programs uncompetitive with those at other institutions. Science and in this regard, Chemistry, are significant prestige drivers for the reputation of SFU and therefore should be financially supported at an appropriate level.

Recommendation #12: We urge the Central Administration to reinstate the previous funding model to assist the Faculty of Science in managing its programs.

There is a strong desire on the part of the Chemistry department to hire more women faculty. They are considering the possibility of a targeted search in this respect regardless of discipline. We were told that that a faculty search targeting women is possible but that the ad must be drafted in such a way as to minimize the possible charge of discrimination against other groups.

Recommendation #13: We strongly support the hiring of talented female faculty members and the use of a targeted search, if possible, in this regard. It was suggested that using a Tier 2 CRC position to recruit the very best might be useful. We agree provided that such a Chair is available to Chemistry and the research area being filled is strategic for Chemistry and for the Faculty of Science.

Teaching Faculty: The department is well served by its Lecturers. We were particularly impressed that some of the Lecturers are working with research faculty and publishing peer-reviewed articles in the Chemical Education literature. As noted above the main concern of these instructors is maintaining and replacing small heavily used pieces of equipment in the first and second year labs such as hot plates and balances.

Technical Staff: Technical staff members are often the unsung heroes of Chemistry departments. Happily, we sensed that this group in the SFU Department of Chemistry feel for the most part appreciated by the faculty, particularly the Lecturers. They were lauded by their supervisor. The technical staff manage the needs of the programs (highest priority), the research, and external contracts (typically 1-2 samples per week on average). They handle the billing, and troubleshoot the instrumentation. When needed, they work overtime and provide important training for both undergraduate and graduate students.

Although not mandated by their union, the technical staff did not seem opposed to more regular job evaluations.

Recommendation #14: We suggest that staff evaluations be done on a biennial basis. The advantage of doing this is to ensure that the duties and responsibilities as outlined in their job descriptions continue to reflect reality.

The staff in the Physical/Analytical labs do yeoman work maintaining the lab equipment. They would appreciate being consulted when replacement equipment is eventually procured. We agree with this as they have valuable expertise and will be on the front lines in working with the instrumentation. They feel that the space in the Physical/Analytical laboratories could be better utilized, with clear delineation

between office and operating space. The lab would also benefit from the addition of one more fumehood.

There is a worry about maintaining glassblowing capabilities for Chemistry and indeed for the university. The current glassblower is highly valued but may be nearing the end of his career. Scientific glassblowers are becoming very difficult to find.

Recommendation #15: We strongly recommend that a succession plan for a new glassblower be devised now. If possible, bringing someone new in before the current glassblower retires would be desirable in that the new person could be cross-trained on the specific equipment in the shop, and be brought up to speed quickly on the billing and administrative functions of the shop.

Administrative and Support Staff: We were struck by the positive attitude of this group. They clearly feel Chemistry is a great department and that there is a good rapport between them and the faculty, staff and students they interact with. The current Administrative Staff complement is 3.6 FTE which we understand is typical for units in the Faculty of Science. The main concern of the clerical and secretarial staff revolves around the 0.6 FTE Financial Assistant position. The incumbent has been seconded to other areas of the university for quite a while now. Thus, the financial workload which is growing is being covered off by a combination of hiring temporary help, and staff cross-training. This has been stressful for the group. The department has suggested that funding be obtained to make the Financial Assistant position full time.

While we understand workloads are increasing we do not sense that additional base funding for this staff group would be forthcoming from the Faculty of Science. In reality the request is premature. It would be better to see if the incumbent Financial Assistant Chemistry actually returns to the unit. That should be known within a few months. At that time Chemistry could potentially use their base funding to restructure this staff group to meet their needs.

Recognizing the importance of outreach and community engagement the Department of Chemistry recommended in their Self-Study that the Faculty of Science fund a Science Outreach Director in the Dean's Office. This has resolved itself nicely in that a highly qualified individual will take on this role as part of a spousal accommodation for the new Provost and Vice-President Academic.

5. Other Issues

- a) **Gender Balance:** We met with a contingent of female faculty members who expressed their concerns regarding their experiences as members of the Chemistry department.

They told us that the unit lacks a clear equity plan, and although they know there is a wish to hire more women, feel, correctly, that equity is more than just about positions. It is also about inclusiveness and mentorship.

They indicated that they have all experienced low-level sexual bias on occasion which has made them feel isolated and uncomfortable. They acknowledge however that it is probably not a conscious attitude on behalf of their male colleagues. Surprisingly, they feel this is a greater issue more with the younger male faculty. All women felt they had received condescending or disrespectful comments. Unfortunately, they don't feel there are robust mechanisms to address their concerns.

The contingent provided a number of suggestions to rectify this situation:

- They would like to see the University Faculty Award for Women and Minorities be reinstated at the national level. This is of course well outside the scope of our mandate and what SFU can do. Typically University Presidents and their VPRs petition the government for their highest priorities during budget season. It is our understanding that the last few years sustaining CFI and the Discovery Grants programs has been their main focus.
- The department should commit to replacing some of the retiring faculty with female faculty, perhaps linked to a CRC award. As noted above, the Chair is very interested in exploring this option.
- The department should establish a Mentorship Committee. At one of our institution untenured junior faculty meet with their Chair monthly. We support mentorship although the frequency of meeting with a mentor might depend on the needs of the specific individual. Indeed, the unit could only benefit by developing a culture of mentorship at all levels.
- The contingent suggested that additional female faculty be included on the most significant committees including tenure and promotion. They recommended that steps be taken to ensure that every year two female faculty be on the tenure promotion committee, one from the teaching stream and one from the research stream.

Recommendation #16: Gender equity is a complex cultural issue where it is easy for misunderstandings to arise on both sides. It is nevertheless critical that the Chair and the department be much more sensitive to these issues, and to understand that no level of discrimination can be tolerated. We recommend that the department explore the idea of creating internal department guidelines for the tenure and promotion committee, increasing the SFU requirement of 1 female committee member to 2 provided that this is consistent with the compositional expectations of the Collective Agreement. If it is, we suggest having 2 female research faculty on the

committee for tenure and promotion of research faculty, and one female research faculty and one teaching faculty for decisions concerning teaching faculty.

Recommendation #17: There are probably not enough female faculty in any given Science unit including Chemistry to rotate through the membership of a departmental Equity and Diversity Committee. We suggest therefore that the Dean consider striking such a committee at the Faculty level. This committee could also connect women from different units providing an additional level of mentorship opportunities.

- b) Junior Faculty:** The newest Chemistry faculty hires indicated that while they were happy within the department, conditions could be improved when future colleagues join SFU. The main issues they faced coming to SFU were:
- Difficulty accessing start-up funds in a timely manner although they deemed the magnitude of the start-up funding to be adequate.
 - Difficulty navigating the SFU systems; particularly purchasing.
 - Finding their space unsafe or in a poor operating condition upon arrival.
 - Difficulty recruiting graduate students in competition to established colleagues.
 - Difficulty in finding time to get their research programs going when faced with their teaching obligations.
 - Receiving verbal promises around space that is actually not available, or around assistance with immigration, and the allowable uses for start-up funding.

We do not see any mal-intent on the part of the department. This is simply an awareness issue which might be dealt with in the following ways:

Recommendation #18: We suggest a small manual be prepared for incoming faculty outlining the processes and procedures around the SFU administrative systems, the library, etc. Although the junior faculty acknowledged that the senior faculty were approachable when their advice was solicited, the department perhaps could be more proactive in assigning a specific mentor to help integrate each new colleague. This might be accomplished by establishing a mentorship committee.

Recommendation #19: We recommend that misunderstandings around space, immigration, and/or teaching relief can be eliminated by moving away from verbal commitments to ensuring these items are actually written into the Letters of Offer. It is simply unacceptable that new faculty arrive to find their assigned space unsafe or inoperable, regardless of the circumstances. These types of situations could be avoided by the department being a bit more diligent in this regard.

Recommendation #20: It was surprising to us that the nominal start date of a new faculty member is September 1st just as the fall teaching term is beginning and very close to the time of their first Discovery Grant submission. We recommend that new faculty begin their new appointments on July 1st, if possible. The 2 months before term starts can make a big difference in ensuring a successful start. If the problem with releasing start-up funds quickly is due to processes at SFU then the department might consider loaning the money in advance to allow the new members to hit the ground running. This possibility of course would depend on whether the unit has the money to do this.

If it is the norm to provide a one term teaching release for new faculty, it might be useful to consider also formalizing those agreements in the Letter of Offer. While we can see benefits of having teaching relief in either the fall or the spring terms the group we met felt the spring term would be better.

- c) **Adjunct Faculty:** We met with one faculty member who wanted to make the case for a new muonium chemist. His preference is a colleague at TRIUMF who already has adjunct status in Chemistry at SFU. We have already discussed the hiring priorities of the department. However, it appears that the adjunct in question is not listed on the departmental web site, nor does he receive emails and other forms of communications from the department on a regular basis. This strikes as a lost opportunity for the department.

Recommendation #21: We suggest that the unit consider better integrating their adjuncts especially those associated with the Nuclear Chemistry group to support the teaching and research activities in that theme area..

Acknowledgements

The Committee would like to thank the Department of Chemistry, the Faculty of Science and the Provost's Office for their hospitality and for all the arrangements made that ensured that the site visit was as comprehensive, informative and enjoyable as possible.

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
CHEMISTRY	March 30-April 1, 2016	Dr. Steven Holdcroft	Dr. Claire Cupples
<p>Notes</p> <ol style="list-style-type: none"> 1. It is <u>not</u> 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. 2. Attach the required plan to assess the success of the Educational Goals as an addendum (Senate 2013). 3. Should any additional response be warranted, it should be attached as a separate document. 			
1. PROGRAMMING			
<p>1.1 Action/s (description what is going to be done):</p> <p>1.1.1 Undergraduate:</p> <ul style="list-style-type: none"> • Physical/Analytical laboratories. <i>Rec. #2 "Despite the magnitude of the problem and the costs, the time for action to replace the equipment in the undergraduate Physical/Analytical Laboratories is now. Students are simply not being trained adequately in the use of modern analytical instrumentation to be competitive for employment after graduation."</i> Centre for self-directed studies. <i>Rec. #7 "We recommend that, depending on the funding available, Phase 1 for establishing the Centre for Self-Directed Studies be done if needed in several steps, and perhaps over several years."</i> Response: The Department fully recognizes the urgent need to replace the equipment in the undergraduate physical/analytical laboratories - a situation that was identified in 2008 (the year of our last external review). During the last 6 years, \$450K has been invested to address the laboratory deficiencies identified at that time, but this is a fraction of the cost required to replace equipment and supplies, which is now estimated at \$2.8M. In the absence of sufficient funding, and with the view to developing innovative programs the Department spearheaded a proposal to establish the Centre for Self-Directed Studies (see <i>Rec. #7</i>) that would partner the Department with a multi-national firm to equip, supply, and help maintain the Analytical and Physical Chemistry Laboratory, but more importantly, transform the way that our undergraduate students are taught in this core subject in an innovative way. This partnership requires both a 5 year+ University commitment to support the on-going needs of this undergraduate laboratory and internal contributions to match the industrial cash and in-kind contributions. Key components of this opportunity include the utilization of existing space, engaging students with industry-inspired and modern laboratory exercises, developing critical thinking skills and inspiring creativity, maintaining analytical integrity, training students to work as individuals as well as in teams, equipping students with their own supplies, encouraging an honest self- 			

evaluation of skills and providing timely assistance to students to refine and improve their skills, training of essential skills to prepare samples for analytical processes, and replacing antiquated equipment with more robust, modern and industrially relevant equipment. Working closely on technological and industrial-relevant challenges, using pre-commercial instrumentation will better prepare the student for the workforce and foster future innovation and entrepreneurship.

The proposed Centre requires funding of \$8M over a period of 5 years to enable our Department to adequately teach essential skills required of analytical scientists (e.g., sample and data integrity, on-going personal skill refinement, and critical thinking in the laboratory) while also engaging more students (e.g., from other Departmental courses, as well as courses from departments beyond our own) than previously possible. This will be enabled through the installation of better equipment, improved maintenance of the equipment, access to sample preparation tools, implementation of an informatics system for process development, data handling and report management, and development of 90 new industry-inspired (real life) laboratory exercises. To this end, the Department has engaged a multinational partner that would provide \$4M in cash and in-kind contributions towards the Centre, but which is contingent on the University raising an additional \$4M (over 5 years).

Action: The Department has formed a committee to oversee the plans to upgrade the equipment in both the Physical and Analytical Chemistry Laboratories and to implement the Centre for Self-Directed Studies with renewed vigor with the Dean of Science and the Vice Presidents. A detailed budget has been created for establishing this Centre; vision and mission statements have been prepared and shared within SFU; and promotional materials have been created. A commitment from the University is required to create the Centre; without this commitment the \$4M cash and in-kind contributions from potential partners cannot not be leveraged, and will not be realized.

The Department continues to foster the relationships with these partners to maintain their interest, and will continue to work with members of the University to bring forward a plan for implementation by May 2017. It is proposed that the first phase of this initiative is to immediately secure funds (\$2.8 M) from the university to replace outdated equipment and supplies. Phase 2 is to raise an additional \$1.2 M over the next 5 years, bringing the total to \$4 M, to secure and leverage the \$4M in cash and in-kind contributions from the multinational partner, required to form the Centre for Self-Directed Studies.

- **Director of LON-CAPA.** *Rec. #3 "Develop a succession plan to replace the Director of LON-CAPA."*

Action: The Departmental Information Technology (IT) committee has met to evaluate both the use of LON-CAPA and the role of the Director of LON-CAPA to ensure that the needs of the Department continue to be met. As a result, the Department is seeking approval from the Dean for a limited term Teaching Support Technologies position (projected to start August 2016) to maintain and further develop the LON-CAPA services used in the Department.

- **First-year course offerings.** *Rec. #5 "We recommend that the department explore whether some of the first-year course offerings can be rationalized to reduce the associated teaching commitment, especially as some of these courses are offered in all 3 semesters."*

Action: The Department will review the number of first-year courses and the frequency of offering, and implement appropriate changes by September 2017.

- **1-unit course modules.** *Rec. #6 "We urge the university to support Chemistry's innovative approach of developing 1-unit course*

modules.”

Action: The Department is developing a 1-unit course on scientific communications (see Rec. #8 below) as a pilot project, projected for the Fall 2017 semester.

- **Communications skills (written and oral).** *Rec. #8 “We recommend that the department ensure that all students have the opportunity to enhance their communications skills (written and oral), and that they receive timely feedback in this regard.”*

Response: The Department recognizes the importance of communication skills and will work to ensure that students have improved opportunities in this regard.

Action: The Department is reviewing the implementation of its current W-designated courses to ensure that students receive appropriate instruction and timely feedback on written assignments. The Department is developing a complementary 1-unit course (see Rec. #6 above) on scientific communication that focuses on developing oral presentation skills.

1.1.2 Graduate:

- **Modular courses.** *Rec. #10 “We strongly support the development of modular courses at the graduate level. Effort should be made to identify topics and instructors, and to schedule the modules at least one year in advance so that students can plan accordingly.”*

Action: The Department is in the process of introducing modular courses at the graduate level. As a pilot project, a special topics course in Chemical Biology (CHEM 759) will be offered in modular form in the Fall of 2016. This will be followed by a staged introduction of further modular courses. The goal is to offer at least one modular course in each of the core scientific disciplines, with certain modules covering the core competencies of the field (preparing students for CHEM 802 and CHEM 808), and other modules serving to diversify the range of topics taught. The Department Graduate Studies Committee will work closely with faculty members to identify potential topics for inclusion in modular courses.

- **Graduate student stipends.** *Rec. #11 “We encourage Chemistry to re-examine their graduate student stipend offers.”*

Response: The Department wishes to be competitive and fair in regards to graduate student stipends. However, it should be recognized that the Department has no control over TA and graduate fellowship stipends, which supervisors must supplement from research grants.

Action: The Department Graduate Studies Committee has conducted a survey of stipends for chemistry students at universities across Canada. In terms of their net income (after subtraction of tuition fees), SFU Chemistry students are increasingly falling behind peers at comparable chemistry departments. Over the last 5 years, the spending power of SFU’s chemistry graduate students has decreased by 10 to 15%. Following this assessment, the DGSC will make a recommendation for increases in the stipend levels for M.Sc. and Ph.D. students that will be voted on at a Department meeting. It is planned to complete this process before the end of the Fall 2016 term.

1.2 Resource implications (if any):

There are no significant resource implications to develop a proposal for implementation of a plan for the acquisition, installation and maintenance of new equipment nor for the plan of the Centre for Self-Directed Studies (*Rec. #2,7*), but there will be for the

implementation of these plans. Resources will be required to install and operate the equipment, to create the new laboratory exercises and workshops proposed for the Centre, and to maintain the on-going relations with one of the proposed industrial partners that are critical to equipment maintenance, equipment renewal, and other support envisioned for the Centre. \$4M cash and in-kind contributions are available from external sources, if matched by the university. Phase 1: \$2.8 M from the university to replace outdated equipment; Phase 2 raise an additional \$1.2 M over 5 years and leverage with the \$4M in the form of cash and in-kind contributions from a multinational partner to form the Centre for Self-Directed Studies.

A succession plan for Director of LON-CAPA requires continuity of that position. There are no direct university resource implications anticipated for evaluating first-year course offerings, 1-unit course modules, or for the other items listed above.

1.3 Expected completion date/s: Listed above

2. RESEARCH

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

- **Minor equipment. Rec. #4** *"We recommend that the university establish a pool of money for minor equipment that Faculties can compete for annually."*

Response: The Department fully endorses this request as the current NSERC funding and allocation model disadvantages those researchers applying for small pieces of equipment. There is a constant and consistent need to upgrade small pieces of equipment for our undergraduate laboratories and for research purposes.

2.2 Resource implications (if any):

There will be resource and financial implications to develop a pool of funds for minor equipment. The extent of the implication depends on the extent of the initiative. It is expected that such requests will be in the range of \$50,000 to 100,000 annually for the Department of Chemistry.

2.3 Expected completion date/s: Listed above

3. ADMINISTRATION

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

- **Equity and Diversity Committee.** *Rec.#17 "We recommend that the Dean consider striking an Equity and Diversity Committee at the Faculty level."*
Response: The Department recognizes the necessity of equity and diversity in the Department, Faculty, and University, and fully embraces this recommendation.
Action: A new Mentorship and Professional Development Committee has been approved by the Department (as of June) and will work with the proposed Equity and Diversity Committee at the Faculty level. The membership of this committee will be formalized by Sept 2016.
- **New Faculty.** *Rec. #18 "We suggest a small manual be prepared for incoming faculty outlining processes and procedures. The department perhaps could be more proactive in assigning a specific mentor to help integrate each new colleague. This might be accomplished by establishing a mentorship committee." Rec #19 "We suggest that misunderstandings around space and/or immigration in particular can be eliminated by moving away from verbal commitments to ensuring they are actually written into the Letters of Offer."; Rec.#20 "We recommend that new faculty begin their appointments on July 1st, if possible."*
Response: The Department recognizes the issues faced by junior faculty and agree with the suggestions that commitments should be firmed up, clarified, and documented as much as possible.
Action: (a) The Mentorship and Professional Development Committee described above will serve to address the needs of new and junior faculty. A manual will be compiled to document frequently used procedures and policies in our Department, and kept up-to-date by this committee. This manual, along with information about professional development offered through the university, will be provided to new hires upon their arrival. The Mentorship and Professional Development Committee will also meet with the new faculty member to arrange for mentorship and to discuss other training opportunities in the University. (b) commitments made to a candidate prior to their arrival will be appropriately documented. The Department will recommend that new faculty begin their appointments on July 1st, if appropriate.
- **Adjunct Faculty.** *Rec. #21 "We suggest that the unit consider better integrating their adjuncts especially those associated with the Nuclear Chemistry group to support the teaching and research activities in that theme area."*
Action: The Department will develop and consider the integration of adjuncts on a case-by-case basis, as opportunity arises.
- **Administrative and Support Staff.** *Page 18 of External Review Report states. "The main concern of the clerical and secretarial staff revolves around the 0.6 FTE Financial Assistant position. The incumbent has been seconded to other areas of the university for quite a while now. Thus, the financial workload which is growing is being covered off by a combination of hiring temporary help, and staff cross-training. This has been stressful for the group. The department has suggested that funding be obtained to make the Financial Assistant position full time."*
Response: While the Review Committee did not make any outright recommendations on this matter, the need to increase the Financial

Assistant position to > 0.6 FTE remains a high priority from the viewpoint of the Department. We continually fail to meet Departmental expectations in matters of finance in a timely manner. To state that this is a stressful situation for the group is an understatement. **Action:** The Department has recently re-addressed and reconfirmed the need to increase the Financial Assistant position. The Department continues to address this issue.

2.4 Resource implications (if any):

Implementation of a Mentorship and Professional Development program will have budgetary implications in the form of professional workshops and the time of Departmental staff. Increasing the Financial Assistant position to > 0.6 FTE, ideally to 1.0 has clear budget implications.

3.2 Expected completion date/s: Listed above

4. WORKING ENVIRONMENT

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

- **Female faculty members. Rec.#13** *"We strongly support the hiring of talented female faculty members and the use of a targeted search, if possible, in this regard."*
Response: For the past two years the Department has, on its hiring plan, recommended the hiring of a female faculty member using a targeted search.
Action: The Department will continue to pursue opportunities to hire female faculty members using any relevant provisions of the collective agreement. Each new hiring committee in the department will work with appropriate experts to minimize unconscious biases.
- **Increasing the number of female faculty members on the TPC. Rec. #16** *"We recommend that the department explore the idea of creating internal department guidelines for the tenure and promotion committee, increasing the SFU requirement of 1 female committee member to 2 provided that this is consistent with the compositional expectations of the Collective Agreement. If it is, we suggest having 2 female research faculty on the committee for tenure and promotion of research faculty, and one female research faculty and one teaching faculty for decisions concerning teaching faculty."*
Response: The Department fully endorses the need to strive for, achieve, and maintain gender equity. The recommendation of placing more female faculty on onerous committees such as the TPC must be balanced against over-subscribing female faculty members on committees to the detriment of their research programs and teaching duties.
Action: The Department will explore the idea of creating internal department guidelines for the tenure and promotion committee that increase the number of female committee members on the TPC. However, it is recognized that there are ongoing negotiations between

SFUFA and SFU's upper administration concerning the composition of TPCs. The Department is awaiting clarity on this issue.

- **Staff evaluations. Rec. #14** *"We suggest that staff evaluations be done on a biennial basis."*

Response: The Department concurs.

Action: SFU Human Resources has initiated a Performance Development Program which includes an ongoing evaluation system for staff. The Department will be commencing its involvement in the program over the next year.

- **Glassblower. Rec. #15** *"We strongly recommend that a succession plan for a new glassblower be devised now."*

Response: This situation has become more acute with the announcement that the Faculty glassblower is retiring at the end of July.

Action: The Department will review and update the glassblower job description to best fulfill the needs of the Department and Faculty of Science. A committee of faculty members and the Manager, Laboratory Operations will conduct a search for a suitable candidate, and an advertisement for the position will be posted in July. A tentative agreement has been made with our previous glassblowing technician to orient and train the new technician. The Dean has agreed to provide support for this training.

4.2 Resource implications (if any):

There are financial implications to hiring new faculty members. There are no direct resource implications for the other items listed above.

4.3 Expected completion date/s: Listed above

5. SPACE (OTHER)

5.1 Action/s:

- **Space. Rec. #1** *"We strongly urge the department to strike a committee to consider how their space allocation could be better optimized to meet their current needs, and those going forward."*

Action: A new committee was approved by the Department at its June meeting. The committee will assess the allocation of space, with a view to providing recommendations that meet the Department's current and future needs. A comprehensive report will be provided to

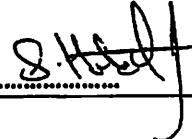
the Chair by May 2017.

5.2 Resource implications (if any):

There are no significant resource implications in providing recommendations, but there may be implications for the implementation of the recommendations.

5.3 Expected completion date/s: Listed above

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>S. Holdcroft</u> </p> <p>Title <u>Chair</u></p>	<p>Date</p> <p><u>Aug 26th, 2016</u></p>
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Section 2 - Dean's comments and endorsement of the Action Plan:

The Department of Chemistry has done a very good job of responding to the External Review and developing an Action Plan that will guide evolution of the department over the next few years. I will comment here primarily on items from the Action Plan that have implications for the Faculty of Science.

Programming:

There is no doubt that the deplorable state of equipment in the Physical/Analytical Laboratories is having a detrimental effect on undergraduate education. The department's plans for integrating equipment upgrades with modernization of the curriculum and real world training, through a Centre for Self-Directed Studies, are commendable; they have my full support. However, the latest iteration of the Faculty (budget) Allocation Model no longer takes discipline-specific educational cost per student into account, making it impossible to fund initiatives such as these out of the Science base budget – at least in the short term. If it is to be realized, this plan will need considerable financial support from the university.

The Faculty of Science has funded a limited term staff position as Director of LON-CAPA for the 2016-17 academic year. I encourage the department to spend this year planning for the future of on-line learning tools including, *but not limited to*, LON-CAPA.

While I encourage the department to explore the potential of modular course offerings and the university to accommodate the atypical course credits that this may involve, I do recommend that the department carefully consider the possible impact of such courses both on pedagogy and on accumulation of sufficient credits for degree completion.

Research:

The Faculty of Science does have a mechanism, in collaboration with departments, for funding the replacement of teaching lab equipment on an annual basis, some of which is no doubt used by researchers between semesters. In addition, we facilitate the application process for equipment funding through the NSERC RTI program.

Administration:

I intend to set up an Equity and Diversity Committee at the Faculty level, and encourage the university to expand such activities across the institution.

I am working with the Chair of the Chemistry Department to determine how best to support the needs for financial assistance. We have put a stop to the revolving door of temporary staffing and are currently advertising for a permanent person for the 0.6 FTE position. Staff members in the

Dean's Office will also work with Financial Assistants or their equivalents in all of the departments to develop best practices as the university transitions to the new financial system. If enhanced staff support in Chemistry is still necessary next year, even with this additional Faculty-level support, I will work with the Chair and departmental Manager to consider other options.

Working Environment:

I believe that the emphasis on research stardom in chemistry departments across Canada, reflected in and driven by the grant allocation process in the Chemistry committee at NSERC, leads to a perpetuation of gender imbalance – even more so than in other science departments. I strongly encourage the department to consider how best to act on its commitment to equity and diversity, particularly as it applies to increasing the recruitment and retention of female faculty. The changes around selection of membership in departmental Tenure and Promotion Committees in the proposed new collective agreement will, if ratified, provide another mechanism to meet the recommendation for increased TPC diversity.

Faculty Dean

Clayton P. H.

Date

August 29, 2016

Chemistry Graduate Educational Goals Action Plan

1. Introduction

All chemical professions require a profound and broad fundamental knowledge of chemical principles. This is mainly developed at the undergraduate level. The specific objective of Graduate studies is to prepare students for more specialized, higher-level positions: faculty positions in academia, senior research positions in government-funded laboratories, principal scientist positions or executive roles in industry, or leading roles in policy-making or public administration. Any of these positions also requires strong skills in: scholarly research using conventional and modern media; critical thinking and problem solving; project planning and management in an increasingly cross-disciplinary and collaborative environment; and astute, competent and effective communication (written and verbal).

The department is committed to maintaining high academic standards enforced at the faculty level and providing continual access to state-of-the-art infrastructure and resources. Realizing the changing needs of the rapidly transforming national and international job market, the Department is particularly devoted to encouraging interdisciplinary research across Departments. Collaborative research projects exist with Departments of Physics, Molecular Biology and Biochemistry, and Biological Sciences, as well as the School of Mechatronic Systems Engineering, Beedie School of Business, and School of Research and Environmental Management.

Many of our graduate students gain valuable work experience through involvement in projects with strong relations to external research organizations and industry. These interactions take many forms, including research presentations at project meetings, testing campaigns for newly fabricated chemicals/materials (weeks to months), or direct student placements at partner organizations for extended periods (months to years).

Section 2.1 outlines educational goals of the graduate programs (M.Sc. and Ph.D. programs) in the Department of Chemistry at SFU, formulated in view of the general needs and trends of the changing chemistry workplace described above. Section 3 describes the Action Plan that will be followed to implement the educational goals, to monitor student success in meeting these goals and to take corrective measures in order to refine goals and increase student success.

2. Educational Goals

The educational goals of the graduate programs in chemistry at SFU serve various purposes: consolidate the general chemistry knowledge of our graduate students in fundamental science and areas of socio-economic relevance; provide ample and stimulating opportunities for graduate students to expand into and specialize in areas of chemical analysis/study that offer personal fulfillment and benefit; prepare

each individual student to the best of their ability to meet specific goals for a career in industry/private sector, continued education, or public service.

Educational goals for chemistry graduate students (M.Sc. and Ph.D.):

1. **Expand general chemistry knowledge.** Students will continue to broaden and deepen their understanding of fundamental concepts in chemical theory and experiment as the basis for their sustained success as scientists and educators.
2. **Develop expertise in specific disciplines.** Each student will acquire deep working knowledge in a chosen field of specialization in chemistry.
3. **Ability to effectively communicate and disseminate results.** Students will learn to develop and articulate logical arguments with clarity. They will become confident and competent in writing for and speaking with expert scientific, general scientific and general public audiences on topics specific to their discipline.
4. **Ability to search, comprehend and dispute the literature.** Students will have the ability to search, read and critically assess the primary peer-reviewed literature in order to understand the scientific context and concepts for their research and to synthesize new ideas in their field.
5. **Ability to rationalize complex data sets and to conduct meaningful analyses.** Students will have the ability to produce, analyze and interpret chemical data and reduce their findings to sound conclusions.
6. **Ability for independent and original scientific research.** Students will be able to conceive, design and execute projects in theoretical and/or experimental research in a chemical discipline. Students will learn how to solve significant, newly realized and hitherto unresolved problems in their chosen field.
7. **Responsible and ethical conduct in research.** Students will understand and be committed to maintaining the highest standards of safety, honesty, ethical conduct and integrity.
8. **Teamwork and interdisciplinary collaboration.** Graduates will have developed the ability to work effectively as part of a team; they appreciate the value of cross-cutting multidisciplinary research.
9. **Teaching and mentoring skills.** Students will acquire skills to teach chemistry knowledge to undergraduate students and gain experience mentoring less experienced personnel in a research setting.

3. Action Plan

Table 1 shows the proposed timetable for carrying out our Educational Goals Action Plan. This timetable recognizes and embodies the iterative nature of the process, following the "Define/Collect/Analyze/Action" cycle proposed by the VPA office, and it mirrors the generic timetable provided on the TLC's Educational Goals website.

Year 1	Sept. 2016 – Sept. 2017	data collection
Year 2	Sept. 2017 – Sept. 2018	evaluate data/ recommend changes to curriculum; revise goals, as appropriate
Year 3	Sept. 2018 – Sept. 2019	- implement changes - produce mid-cycle report
Year 4	Sept. 2019 – Sept. 2020	data collection (2 nd round)
Year 5	Sept. 2020 – Sept. 2021	evaluate data/ recommend changes to curriculum; revise goals, as appropriate
Year 6	Sept. 2021 – Sept. 2022	-implement changes

Two mechanisms will be employed for the collection of data required in this process:

(1) The Department will conduct an annual graduate student survey that will explore student satisfaction with course availability, quality of course content/instruction, quality of graduate supervision, as well as access to resources and support for scientific research and career development; as part of this survey, students will self-assess and comment on their performance in view of the Educational Goals stated in Section 2;

(2) The assessment of Educational Goals will become part of supervisory committee meetings and qualifying exams (CHEM 802 and 808); the assessment will be performed by members of the respective committee; the supervisory committee form will be modified to allow for the evaluation of Educational Goals. The following rating scheme will be used for each of the educational goals:

- FE: fully satisfies and exceeds
- FS: fully satisfies
- MS: mostly satisfies (but has some minor weaknesses)
- NS: does not satisfy
- NA: not applicable or relevant at the time of the assessment.

The rating for each goal will be followed by a comment section that will provide the rationale for the rating and include recommendations for improvements for the student. The "NA" rating might be used in the following cases: (i) it will be too early to assess some of the educational goals at the first committee meeting; (ii) there will be cases within a specific discipline where an educational goal is not an essential component of student training (e.g., data analytics in the case of research in natural products synthesis).

The Graduate Secretary will carry out the data collection, with support by the Chair of the Departmental Graduate Studies Committee. The Departmental Graduate Studies Committee will analyze the data and recommendations resulting from this analysis will be discussed with faculty members at Departmental Meetings and graduate students at assemblies of the graduate caucus. Based on feedback received, Educational Goals will be revisited and revised and the programs that they evaluate will be reappraised and modified, if needed.

Chemistry Undergraduate Educational Goals Action Plan

1. Introduction

The Department of Chemistry has identified nine general Program Educational Goals at the undergraduate level; these goals are outlined in Section 2.1. Our primary aim is to ensure that students graduating with a B.Sc. in Chemistry from SFU have a strong foundation in the theoretical underpinnings of modern chemistry, and have acquired the practical experimental skills associated with this discipline. Moreover, we strive to imbue our students with essential tools- such as critical thinking, problem solving, and the ability to communicate effectively- that will enable them to flourish after graduation, regardless of whether they continue as practicing chemists.

The following sections outline our program goals, the context in which these goals were formulated, and an action plan for enacting these goals. A key component of this action plan will be a comprehensive inventory of our core undergraduate courses, which will serve not only to ensure that our global program goals are being met, but also to facilitate the formulation of course-level educational goals, as needed. Critically, this action plan is formulated to strike a balance between the pedagogical aims of Educational Goals and the recognition that our faculty, staff and students should not be unduly burdened by an additional workload as a result of this process.

2. Educational Goals

The goals described in the following subsection were formulated as part of the Chemistry Department self-study document prepared for the departmental external review in 2015/16. These goals were adapted from those commonly implemented by other chemistry departments, notably those in the United States, where the adoption of educational goals and learning outcomes is a more well-established practice. As will be discussed in Section 2.2, we are both aided and constrained in establishing these educational goals by virtue of being an accredited program by the Canadian Society for Chemistry (CSC).

2.1 Statement of Program Educational Goals

Undergraduate students, upon graduation with a B.Sc. Major or Honors degree in chemistry from SFU, will:

1. Have a solid foundation in the fundamentals of current chemical theories and their application to the physical world.
2. Be skilled at analytical reasoning, problem solving, and critical thinking.

3. Be able to design, perform and record chemical experiments and be capable of analyzing the results of these experiments. This includes the ability to critically assess results, identifying and quantifying experimental uncertainties and evaluating methodological limitations.
4. Have hands-on experience with a broad range of experimental methods, and be able to use a variety of modern instrumentation and standard techniques.
5. Be able to communicate the results of his or her work to both chemists and non-chemists, in writing and orally.
6. Be able to use modern library search and retrieval methods to access information about specific chemical topics.
7. Be knowledgeable about chemical safety procedures, including proper methods and regulations for the safe handling, use and disposal of chemicals and the safe use and handling of chemical instrumentation.
8. Be able to identify and solve chemistry-related problems and to apply this to the exploration of new areas of research.
9. Have the experience and ability to collaborate effectively as part of team to solve problems.

2.2 Context of Chemistry Educational Goals

The B.Sc. Major Program in the Department of Chemistry at Simon Fraser is accredited by the Canadian Society for Chemistry (CSC). The CSC is responsible for maintaining educational standards of chemistry undergraduate programs at almost every Canadian university. The guidelines for accreditation can be found at:

www.cheminst.ca/about/cic/csc/csc-accreditation

The Educational Goals developed by our Department shall not supersede the requirements of CSC accreditation.

An important consequence of CSC accreditation is that the Chemistry Department's curriculum is regularly and thoroughly vetted for content by an external source. Indeed, of the educational outcomes listed in section 2.1, goals 1-4 are requirements of accreditation. For this reason, our action plan (Section 3) will focus primarily on Goals 5-9.

A key requirement of CSC accreditation is that all Chemistry Majors must meet a minimum set of standards and have been exposed to a common core of knowledge.

For this reason, our Major program is more closely prescribed than many at SFU. Of the 120 units required for the Chemistry Major, 61 units are accounted for by 20 uniquely specified courses. A further 14-15 lower division units in Math and Physics are required from a limited set of prescribed courses. The large proportion of common core courses helps ensure that all students graduating with a B.Sc. in Chemistry benefit from the stated Program Educational Goals and facilitates the coordination of the global learning objectives with those of individual courses.

3. Action Plan

The discussion that follows focuses on Educational Goals for the Chemistry Major Program. There are several other programs offered through chemistry in conjunction with other departments: the Chemistry/MBB joint major, the Chemistry/Earth Sciences joint major, and the Chemical Physics major. Establishing a clear set of educational goals for these joint programs will require careful coordination with our partner departments, a process that will be facilitated by first articulating the goals for our core program and the courses therein. These joint Major programs, as well as our Minor programs in Nuclear Science and Environmental Chemistry, will be evaluated in the second cycle (years 4-5, Table 1).

Table 1 shows our proposed timetable for carrying out our Educational Goals Action Plan. This timetable recognizes and embodies the iterative nature of the process, emulating the "Define/Collect/Analyze/Action" cycle promulgated by the VPA office, and mirrors the generic timetable provided on the TLC's Educational Goals website.

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During the course of these cycles, we anticipate that our Educational Goals will undergo revision and/or elaboration. Our stated goals, at this time, are very general, and likely will need clarification. We regard this evolution to be an important part of the process.

We foresee the heaviest workload associated with this Action Plan will occur during Years 1 and 2. *In order to facilitate data collection in Year 1, we propose to hire a chemistry undergraduate student to gather information relevant to the courses and program.* Having an undergraduate in this role, preferably one who has taken many of the courses being evaluated, will provide a critical perspective on the program.

Data collection will be carried out in conjunction with the Undergraduate Advisor (Evon Khor), the Departmental Undergraduate Studies Committee and one faculty member tasked with direct oversight of the process. This faculty member will also coordinate the evaluation of data during Year 2, and will receive partial teaching relief to this end.

During the first cycle (years 1-3), our evaluation will focus on the core chemistry courses required by all Chemistry Majors and Honours students. These courses are

listed in Table 2. For all Program Educational Goals, each course will be ranked on a 0-4 scale, with "0" indicating that the course does not significantly promote the educational goal, and "4" denoting a course that strongly supports the goal. We do not anticipate that every course will engage students on every program goal; rather, we wish to ensure that each educational goal is supported across multiple courses and at different levels. Educational goals, if they are to be effective, must not just be introduced in a single course, but be reinforced throughout the program.

To facilitate this process, faculty members who have taught a given course within the last several years will be asked to comment on the relevance of that course for each of the program goals. We will also solicit feedback from undergraduate students in our Major and Honours programs, both through questionnaires and a series of informal lunchtime town-hall meetings. Participation by students is crucial at all stages in identifying both real omissions within our program, as well as perceived deficiencies. From preliminary discussions with students in the program, it is apparent that it is not sufficient to introduce content and pedagogy that satisfy our Educational Goals; these goals, and their relevance to the course and program, must be clearly articulated in order to be truly effective. It is critical that we communicate to the students our expectations and make our pedagogical goals transparent.

One of the potentially most useful mechanisms for gathering student feedback is through student evaluations. Ideally, we would include questions in student evaluations that specifically address the Chemistry Department Educational Goals. Unfortunately, the current incarnation of the Student Evaluation of Teaching and Courses (SETC) does not permit a sufficient number of department-defined questions to satisfy this requirement. *We are hopeful that the SETC system will be evolved to make it a more broadly useful system for data gathering of this type.*

The data collected in Year 1 will be used to inform revisions to existing courses, and the development of new courses. Although these adjustments are formally projected for Year 3, we have already begun this process. For example, feedback from our external review identified the need for more opportunities for students to develop oral communication skills (Goal 5). In response, we are creating a 1-unit course that fills this lacuna.

Table 2. Proposed matrix for evaluating Program Educational Goals for core courses in chemistry.

Course	Program Educational Goals								
	1	2	3	4	5	6	7	8	9
CHEM 121 - General Chemistry and Laboratory I									
CHEM 122 - General Chemistry II									
CHEM 126 - General Chemistry Laboratory II									
CHEM 215 - Introduction to Analytical Chemistry									
CHEM 230 - Inorganic Chemistry									
CHEM 236W - Inorganic Chemistry Laboratory									
CHEM 260 - Atoms, Molecules, Spectroscopy									
CHEM 266 - Physical Chemistry Laboratory I									
CHEM 281 - Organic Chemistry I									
CHEM 283 - Organic Chemistry IIb									
CHEM 286 - Organic Chemistry Laboratory II									
CHEM 316 - Introductory Instrumental Analysis									
CHEM 332 - The Chemistry of Transition Metals									
CHEM 336 - Advanced Inorganic Chemistry Laboratory									
CHEM 360 - Thermodynamics and Chemical Kinetics									
CHEM 366W - Physical Chemistry Laboratory II									
CHEM 380 - Chemical and Instrumental Methods of Identification of Organic Compounds									

Note that the Chemistry Major and Honours programs also require students to take several courses from MATH, PHYS and MBB. These non-chemistry will *not* be evaluated in the first cycle of this action plan.