PROJECT PLANNING REPORT FOR THE RENOVATION OF PHYSICS UNDERGRADUATE TEACHING LABORATORIES AT UTM

REPORT
December 2012

Facilities Management & Planning, University of Toronto Mississauga

I. EXECUTIVE SUMMARY

UTM's first science laboratories were built almost 40 years ago and in many cases the facilities barely meet current regulatory standards. The renovation is essential to maximize the utilization of the existing infrastructure and will support increased numbers of undergraduate, research-based master's and doctoral graduate programs, and provide the updated infrastructure needed to support today's scientific teaching and research.

The proposed project will renovate the area known as Spigel Hall recently vacated by Food and Retail operation. This proposal will allow accommodation of Physics teaching laboratories in an airy windowed area that can support its requirements, and it will free highly serviced space in the D-block of the W.G. Davis building for expansion of wet research laboratories for Biology and CPS. This project is Phase 6 of a multi phased plan to renovate all of science teaching labs, and it will take place in the summer of 2013.

The Physics department is currently engaged in an academic and strategic planning process to support enrollment growth and expansion of lab-based courses. The quality and practicality of the physics education will be significantly improved by using modern laboratory layout to accommodate advances in new physics pedagogy and the development of studio courses that incorporate the blending of lectures and experiments to encourage collaborative work and critical thinking. The laboratory design also provides maximum flexibility so that it can accommodate other, non-Physics users who may require laboratory space that is not heavily serviced. A number of discussions are currently underway, within the context of longer-range academic planning that could result in additional and different programs being located at UTM that would require such laboratory space.

Critical to the payback of the Physics lab replacement is the secondary impact of the chosen location. Rather than re-build in the current location, the heavily serviced D-Block of the Davis building, the lab is being built in the old Spigel Hall space since it really only requires a lighter level of services; power and water. That results in freeing up critically-needed space in the heavily serviced area that will be re-built for faculty research laboratories. In combination with other moves out of D-Block, research laboratories will be provided for between eight and twelve new science faculty. This complex "decanting" from the D-Block is fundamental to our ability to expand our sciences programs and hire additional research faculty.

The proposed schedule for Phase 6 of the renovations is based on advanced planning to allow for construction to commence in April, 2013 immediately after classes finish. It is essential for construction to be completed by the end of August, 2013.

The estimated Total Project Cost for the project is $ 3,092.529 and will be funded from UTM operating fund. Note, the North Building and the Teaching Laboratory Renovations will be funded by the province 70% and UTM 30%. However, due to cash flow from the province and the proposed timing of the projects involved, the proportion of the funding will vary significantly among the related projects.

TABLE OF CONTENTS

II. PROJECT BACKGROUND

a) Membership

Peter Macdonald, Professor and Chair of CPS, UTM
Lynn Snowden, Assistant Dean, UTM
Virginijus Barzda, Associate Professor, CPS, UTM
Gideon Humphrey, Physics Lab Coordinator CPS, UTM
Mylene Vincent, Manager, Finance & Operations CPS, UTM
Nicole Prent, Graduate Student CPS, UTM
Stepanka Elias, Assistant Director, Facilities Management & Planning, UTM
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b) Terms of Reference

1. Review the space utilization of the Physics Undergraduate Teaching laboratories and related support space and demonstrate that the proposed space program will be consistent with the Council of Ontario Universities' and the University's own space standard.
2. Make recommendations describing other models for undergraduate teaching laboratory layout and operation.
3. Review environmental and occupational health and safety processes and procedures, propose improvements to laboratory operation.
4. Identify equipment and moveable furnishings necessary to the project and their estimated costs.
5. Identify all data, networking, communication, and A/V requirements and their related costs.
6. Identify all environmental, occupational health and safety, life safety, security and accessibility requirements and their related costs.
7. Determine a total project cost estimate (TPC) for the capital project, operating costs including the cost of implementation in phases and indentify all other resource costs to the University.
8. Identify all sources of funding for capital and operating costs.
9. Report in October 2012

c) Background Information

The existing physics undergraduate teaching laboratories at UTM have been in service since 1970. They have undergone essentially no renovation or modernization in the ensuing 4 decades. Originally designed to accommodate a total of ~150 students per 5-day week, the actual number has more than doubled to ~ 400 laboratory FCE's in the current academic year. This enrolment growth has placed inordinate pressure on laboratory scheduling. Furthermore, investment in equipment and instrumentation essential for modern physics pedagogy has been minimal, while the current laboratory infrastructure is inadequate to accommodate any such new instrumentation and modern digital interfaces.

The external review committee was likewise concerned for the quality of undergraduate physics education resulting from the lack of investment over many decades.

> "In the upper level physics labs, some of the equipment is 30 years old and in need of replacement. The Senior Administration needs to recognize that credible programs must include specialized courses requiring expensive equipment, even when enrollments are modest. As the program builds, so the equipment will be used more effectively but the program will not expand without modern equipment as a catalyst. As mentioned above, the undergraduate students are very concerned that safety and air quality is not what it should be."

The now 40 years old physics undergraduate teaching laboratories were never designed to accommodate the large numbers of undergraduate physics students CPS must now manage. Nor was the need to provide the electrical, plumbing, computer data links, and other infrastructure associated with advanced and sophisticated instrumentation envisaged, much less the advances in physics pedagogy that have in the ensuing years radically altered best practices in undergraduate physics education.

It is undoubtedly the case that the inadequacies of the physics undergraduate laboratories have contributed to the modest enrollments in upper year physics courses, notwithstanding the large enrollments in lower year physics courses. This has negative implications for the competitiveness of CPS undergraduate physics programs relative to those at other UofT campuses and other universities, and certainly has a deleterious effect on graduate physics programs at UTM.

In recognition of these multiple shortcomings, the UTM Senior Administration signaled the need to begin planning for the renovation of the physics undergraduate teaching laboratories, as part of a multi-phase, multi-year complete renovation of all undergraduate science teaching laboratories at UTM. The physics component of that plan entered the planning stage in Fall 2011, with renovation activity to commence Summer 2013.

Broadly, these plans can be described as follows. The physics undergraduate teaching laboratories will be relocated and renovated to purpose-built space able to accommodate large numbers of students. Nevertheless, these students will be working in small groups, using modern equipment and data acquisition tools to experience the practical applications of the theoretical physics concepts taught in lectures. Separate spaces will be devoted to first year physics versus upper year courses, yet both will be configured in the form of learning "studios" in which students explore for themselves the various demonstrations, in conformity with current best practices in physics pedagogy. Additional specialized spaces providing light and/or sound isolation have been allocated for certain specialized experiments and demonstrations. Technical staff will be provided with office and preparatory space, as well as storage space for equipment.

d) Space Utilization Analysis

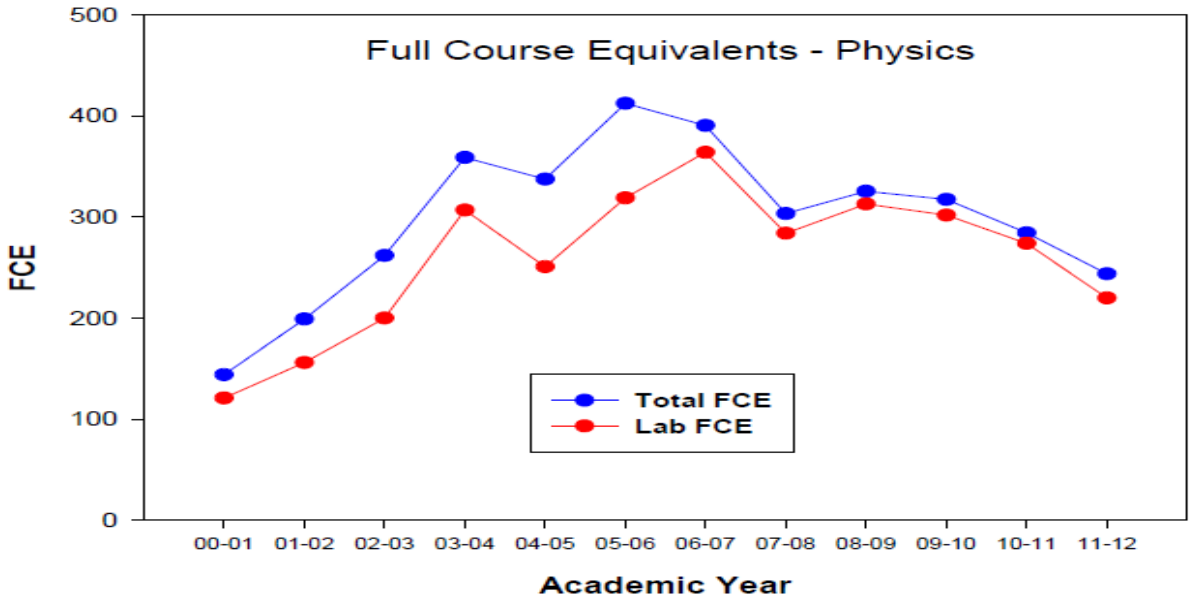
The utilization level of the physics teaching laboratories was evaluated using three indicators:

- Full course equivalents
- Weekly student contact hours
- Laboratory schedules

Full Course Equivalents

Full Course Equivalents (FCEs) are calculated as the sums of all course weights multiplied by the number of enrolled students. The FCE calculation differentiates between full and half courses: a full Y course has a weight of 1.0 and a half course H has a weight of 0.5.

The following chart shows the Total FCE and Laboratory FCEs for Physics over the last few years. The main decrease can be attributed to elimination of "breadth" courses (physics courses for non-science students). This decision was related to funding and courses will be reintroduced as early as September, 2013.



Further increase in student enrolment is expected with the proposed renovation of the laboratory space, modernization of equipment, close coordination of experiments with course material, and changes to the Physics curriculum.

The goal of this renovation is to support enrollment growth in Physics by creating modern laboratory layout to accommodate advances in new Physics pedagogy. Furthermore, the new layout will allow the department to develop studio courses that blend lectures, tutorials and experiments to encourage collaborative work and critical thinking.

Weekly Student Contact Hours

The Council of Ontario Universities (COU) space guidelines provide a quantitative guide to the space required to accommodate undergraduate teaching laboratories and their support space (COU category 2). The amount of space is based on the number of Weekly Student Laboratory Contact Hours (WSCH) and the nature of the discipline.

The table below, for the Fall term of 2011/12, shows that the existing space allocation of 446nasm exceeds the generated (theoretically required) space of 282 nasm. The proposed space will be used for tutorials as well as practical sessions thus increasing utilization and, as described above, accommodate enrolment growth in Physics and allow for the new studio style courses as well as for additional and new programs which could utilize these modern facilities.

UTM Physics Course Information (2011-2012)

COURSE	Practical Lab Hours/Week	Course Enrollment	Contact Hours/Course	COU Space Factor	Generated NASM Fall
PHY136H	1.5	224	336	0.6	201.6
PHY137H	1.5	147	220.5	0.6	
PHY241H	2	17	34	0.6	20.4
PHY242H	2	24	48	0.6	
PHY245H	2	22	44	0.6	26.4
PHY255H	2	13	26	0.6	
PHY324H	4	14	56	0.6	33.6
PHY347H	2	8	16	0.6	

TOTAL	
generated NASM	282
existing NASM	446.9

The department of Chemical Physical Sciences anticipates enrollment growth in Physics of 10% to 15% between 2011/12 and 2015/16.

Laboratory Schedules

The proposed renovation will create three laboratory areas:

- Laboratory 1 will have two teaching pods and capacity of 48 students
- Laboratory 2 will have capacity of 28 students
- Project Laboratory will have flexible work environment for students working on upper year projects

Laboratory 1 will accommodate mostly the large first year class for both tutorials and practical sessions. One week, the first and second sections will have practical sessions while third and fourth sections will have tutorials. The second week the tutorials and practical sessions will be reversed. This approach will provide flexibility in scheduling of lager class sections, and it will allow CPS to organize experiments that match lecture material while maximizing the use of laboratory apparatus.

Laboratory 2 will have a similar set up as Laboratory 1, but it will be half its size. The layout selected will accommodate studio style teaching envisioned as the main course delivery method for the 2nd and 3rd year courses.

General Laboratory Scheduling

The Department of Chemical Physical sciences has extensive plans for the expansion of their curriculum, the increase in student enrollment and the introduction of new physics and

multidisciplinary courses. The proposed renovation will accommodate the current and proposed teaching needs.

The current program will utilize approximately 15 hours per week in each of the new Physics laboratories thus providing for the UTM growth that will include existing and new academic programs and initiatives, many of which will likely require dry teaching laboratories. The proposed renovation was carefully designed to accommodate a variety of dry teaching laboratories utilizing mixture of technology, interactive A/V equipment, and group work areas.

The utilization of the renovated laboratories will be monitored and space capacity used on multi departmental level.

The proposed laboratory area includes laboratory technician work space, preparation space, and efficient storage area. These support spaces will allow CPS to manage access to the laboratory areas and experimental preparation without impact on scheduling on the two larger laboratories.

III. PROJECT DESCRIPTION

a) Vision Statement

Physics in its most basic sense is the study of how things work, and therefore, is both a fundamental part of education and it has been, and will continue to be, responsible for the majority of technological advances that we use in our daily modern life. Therefore, the vision of the Department of Chemical and Physical Sciences at UTM is that students learn physics and experiment in a modern environment that reflects these advancements in both technology and education. In physics, theories and mathematical equations are supported by demonstrations and it is expected that students learn the scientific method to prove the proposed theories by experimentation. Although first year physics students study classical theories, the experiments should utilize modern equipment and data acquisition tools. This not only shows appreciation and perspective on historical experiments, but also prepares future physicists for the technological requirements that will be demanded of them. Therefore, the quality and practicality of the physics education will be significantly improved with the implementation of modern laboratory work stations that are pedagogically sound. In addition, it is also imperative that upper year physics labs are also equipped modern workstations, so that there is continuity in the style and quality of physics laboratory scholarship at UTM. In addition, the proposed laboratory space will be flexible to accommodate advances in new physics pedagogy and the development of studio courses that incorporate the blending of lectures and experiments to encourage collaborative work and critical thinking.

For the vision of the new physics laboratories the following key elements are required:

- Laboratories should be visually attractive, have access to technician's office, adequate equipment storage, and the space should allow students and instructors to move freely through the room at maximum capacity.
- New laboratories and technician office will gain natural light, with adjustable blinds to accommodate low ambient light experiments.
- Computer workstations should be ergonomically designed so that a group of students can easily communicate and access equipment.
- An instructor workstation for pre-lab demonstrations and an independent experimental set-up.
- Each workstation computer should connect to the projector so that interesting experimental results can be shown to the entire class for discussion.

- Internet access at each workstation to enable electronic data collection and submission of work, in addition to access to course material posted online.
- A few specialized rooms for experiments that require light or sound isolation.
- The hallway requires lockers for each student, drop boxes for each section, information boards and a LCD announcement screen.

The integration of the key elements listed above into the design of the UTM physics laboratories will provide students with a quality education that utilizes modern technology and computer methods and encourages group collaborations. These improvements are also directly related to the practicality of the education with respect to the real working world. This vision aims to not only improve the technology and equipment in the laboratory, but to also encourage a positive work environment with a non-cluttered, attractive and efficient space. In addition, the plans give the potential to incorporate advances in physics pedagogy and studio courses. The design plans for the proposed new physics laboratories include the renovation of the former cafeteria on the lower level of the W.G. Davis Building. Therefore, the physics labs are moved away from a high traffic area, and space on the main floor is made available for more high demand uses. Great planning has been taken so that the renovation doesn't disrupt research and other work that is ongoing at the university.

b) Space Program & Functional Plan

Space Program

Room Description	Area [nasm]
Physics Laboratory #1	240
Physics Laboratory #2	115
TechnicianPreparation Area	28.2
Physics Project Laboratory	53.2
Dark Rooms	14.4
Technician Offices	21.1
Total	471.9

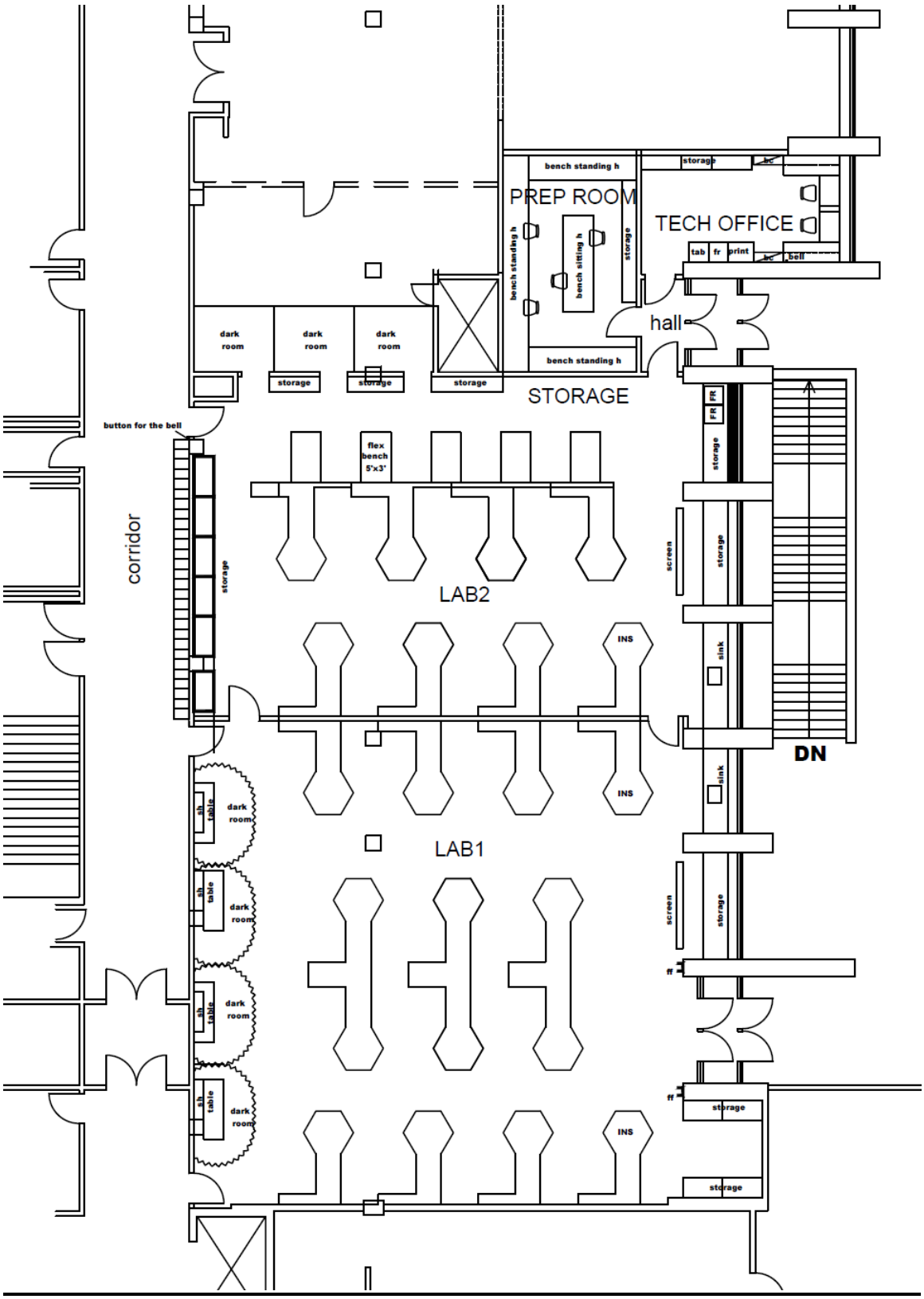
The proposed space allocation of 472nasm represents marginal increase of 5.6% compared to the existing allocation (447nasm).

The renovation will provide teaching efficiencies by creating labs of 48 seats and 24 seats model. This allows flexibility in the scheduling of lager class sections as well as the option of splitting the sections into smaller groups (12 to 24 students). Furthermore the layout will allow CPS to continue offer laboratories at the existing TA to student ratios.

The technology incorporated into the laboratory will include computers at each teaching station, direct visual access to a central demonstration counter, and audio-visual teaching presentation stations. Another design strategy for increasing teaching flexibility is the provision of similarly configured laboratory spaces with ample storage.

The main storage space will allow for shared equipment, materials, and document resources further operational efficiencies for the department. This room will allow for sharing of information and the cooperation among the various technical and academic staff using this space.

Proposed Layout



c) Building Considerations

Accessibility
The University of Toronto is committed to ensuring that its buildings and services are accessible to persons with disabilities and requires all consultants to adhere to University's Barrier Free Design Standards.

The layout of the laboratory will include minimum 5ft of space between student benches. The layout will be designed to have no dead-end corridors, and one of the stations in each lab will be height adjustable. The presentation area will have advanced A/V capabilities and sound enhancement.

Safety and Security
Access to the three teaching laboratories will be controlled by electronic card system. The system will ensure safe operation during main laboratory hours and allow after-hours access to students to complete their individual course work

The doors to the preparation room, technician's offices and between the laboratories will be controlled by mechanical keys. These keys will be distributed to the laboratory technicians only.

All laboratory furniture storage areas are to be lockable to control access to stored apparatus.

A doorbell will be installed in the main hallway with a chime in the laboratory technician office and preparation room to allow students and visitors to reach staff in the back of the teaching laboratory suite.

Computing
Computing and communications will utilize the network already available in the W.G.Davis Building.

The laboratory will have several data ports for presentation areas in additional to wireless environmental throughout the laboratories.

d) Site Considerations

UTM accommodates its academic activities in several buildings across campus. The W.G. Davis Building provides space required for all teaching and research activities of all physical and life sciences. The North Building Reconstruction and Kaneff Building expansion, both recently approved, will provide urgently needed space for academic offices, dry laboratories and classrooms. However, at the present time there is no funded plan to create significant science expansion. Therefore, the modernization and renovation of the existing serviced space in the W.G. Davis Building for research and teaching laboratories is more important than ever.

e) Campus Infrastructure Considerations

All services required by the operation of the renovated laboratories are available within the existing Davis Building. No modifications to the base building systems are required.

f) Environmental Impact – Construction/Renovation

Design and construction will be in accordance with all applicable environmental, health and safety regulations and University of Toronto policies and standards.

The current lighting, fluorescent lighting ballasts may contain PCB's which are substances that are heavily regulated under the Canadian Environmental Protection Act. The benefits of the lighting retrofit to new T-8 lighting ballasts include removal of PCB's and replacing them with ballasts that do not include PCB's or other highly regulated materials. In addition, through the lighting retrofit, the laboratory will reduce energy consumption, and reduce the generation of waste from lamp replacement due to the much longer lifetime of the proposed lighting retrofits.

The proposed renovation is in an area with large windows which will provide ample natural light to the new laboratories.

g) Secondary Effects

This project will include modification of the existing food servery and relocation of the existing dishwasher to accommodate continuous operation of W.G. Davis Building food services.

Four large classrooms are located directly above the project area and will be taken out of service for the duration of the renovation.

h) Staging

Nor staging is required for this project; the space to be renovated is a new allocation to the department of Chemical and Physical Sciences and it is vacant.

i) Schedule

The Renovation of the Physics teaching laboratories will occur in the Spring and the Summer of 2013.

Consultant Selection Approval CaPS Exec	November 2012
Consultant Selection and Design	December 2012
PPR approval P&B	January 16, 2013
Lab Bench Tender	February 2013
Permit Application	February 2013
General Tender	March 2013
Construction	April-August 2013
Occupancy	September 2013

The proposed schedule is based on advanced planning to allow for construction to commence in April, 2013 immediately after classes finish. Furthermore, since the proposed construction time of five months will be very tight, provisions in the academic teaching schedule will be made to allow shift of laboratory sessions to start in mid-September, 2013.

IV. RESOURCE IMPLICATIONS

a) Total Project Cost Estimate

The total estimated cost of the project is $ 3,092.529 million dollars which include estimates or allowances for the following items:

- o construction cost (assuming lump sum type of tender to a qualified general contractor)
- o contingencies
- o taxes
- o hazardous waste removal
- o secondary effects
- o demolition
- o permits and insurance
- o professional fees
- o moving, staging
- o furniture and equipment
- o computer and telephone terminations
- o security
- o commissioning

Equipment and Furniture Cost
The proposed renovation will include new equipment to allow for fit up of the new space, replace dated equipment, and accommodate new experiments necessitated by changes in course curriculum. Appendix B, Room Specification Sheets, include a full list of existing and new equipment and furnitureand is available on request.

The details of the total project cost estimate are available on request.

b) Operating Costs

The cost for utilities in the renovated area will be higher than the existing utility costs due to the substantial increase in exhaust air requirements. The changes to equipment and infrastructure will result in a greater energy efficient design, monitoring and tracking of energy consumption.

Increased building engineer man-hours to maintain the lab and demands on external contractor skill sets will result in increased operating costs. This is the direct effect of increasingly complex lab design and higher standard of research / teaching occupancy requirements.

With expanded cleaning requirements due to increased course activity, the total costs (electricity, operation and maintenance) for Physics 1st floor teaching laboratory space are anticipated to increase by $18.800 per annum.

c) Funding Sources

Phase 6 is to be funded from the UTM Operating Fund.

V. RECOMMENDATIONS

Be It Recommended to the Academic Board:

a) THAT the Project Planning Report for the Renovation of Physics Undergraduate Teaching Laboratories in the W.G. Davis Building at the University of Toronto Mississauga, dated December, 2012, be approved.

b) THAT the project scope for the proposed renovation of the Physics Teaching Laboratories, Phase 6 of a multiphase project, with a total project cost of $ 3.1 million to be funded from the UTM Operating Fund to be approved in principle.

APPENDICES

Appendix A: Existing Space Inventory
Appendix B: Room Specification Sheets (available on request)
Appendix C: Equipment List (available on request)
Appendix D: Total Project Cost (available on request)

APPENDIX A:

EXISTING SPACE INVENTORY

The following table summarizes the space inventory affected by the proposed renovation.

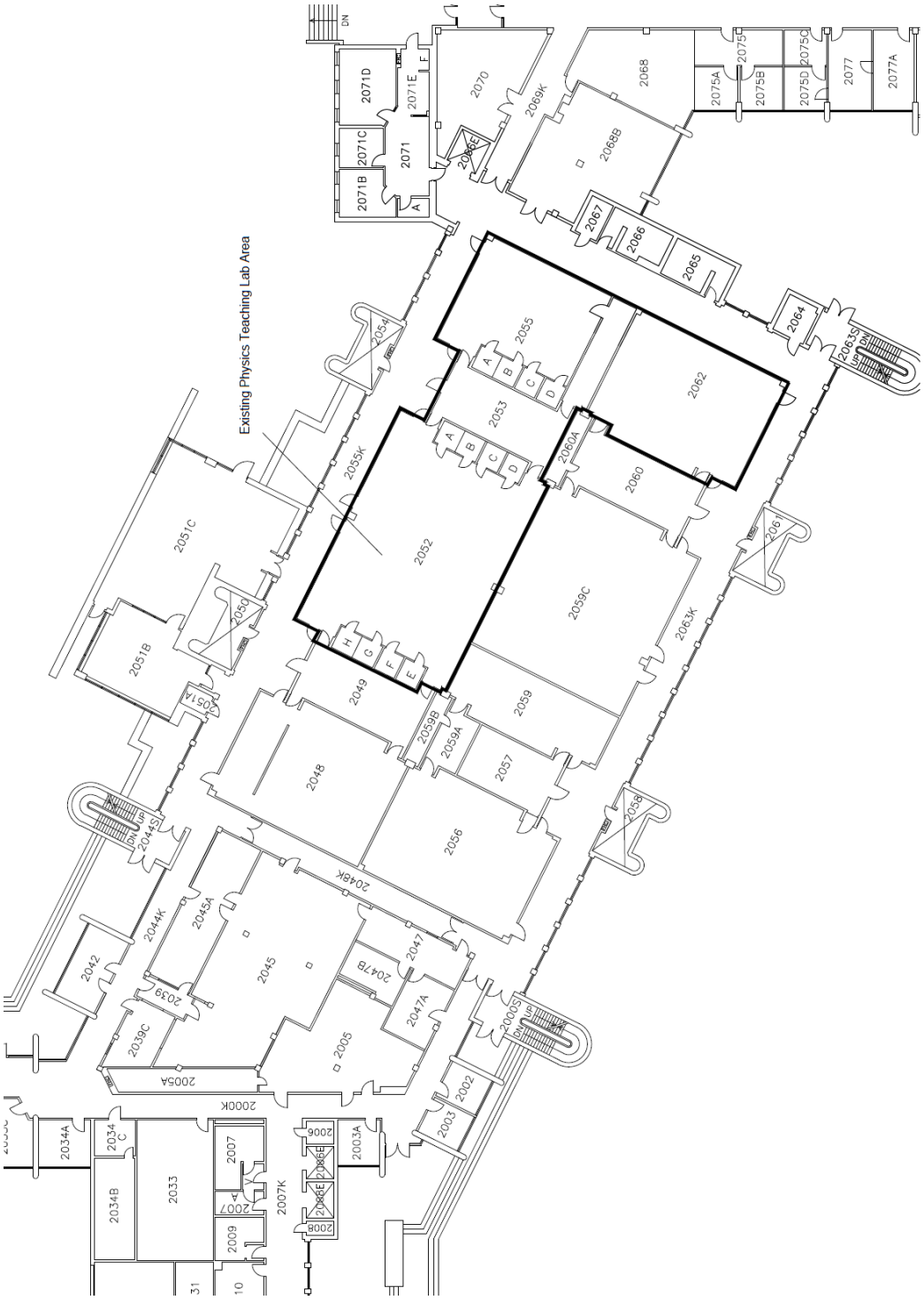
Existing UTM Physics Teaching Laboratory Space Inventory

Building Name	Room No. Sfx.	Department Name	COU Category Code	Proration Type %	Room Details Stns	Room Alloc Comments	Area
W. G. Davis Building	2052	UTM- ChemPhysScien	02.1	100	50	Wet Lab	216.62
W. G. Davis Building	2052A	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.28
W. G. Davis Building	2052B	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.28
W. G. Davis Building	2052C	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.15
W. G. Davis Building	2052D	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.15
W. G. Davis Building	2052E	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.15
W. G. Davis Building	2052F	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.15
W. G. Davis Building	2052G	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.28
W. G. Davis Building	2052H	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.28
W. G. Davis Building	2053	UTM- ChemPhysScien	02.3	67	0	Lab Prep	30.57
W. G. Davis Building	2055	UTM- ChemPhysScien	02.1	100	24	Wet Lab	106.4
W. G. Davis Building	2055A	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.28
W. G. Davis Building	2055B	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.28
W. G. Davis Building	2055C	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.15
W. G. Davis Building	2055D	UTM- ChemPhysScien	02.3	100	0	Darkroom	3.15
W. G. Davis Building	2062	UTM- ChemPhysScien	02.1	45	0	Darkroom	54.77
Total							446.94

Existing UTM Space Area to be renovated

Building Name	Room No. Sfx.	Department Name	COU Category Code	Proration Type %	Room Details Stns	Room Alloc Comments	Area
W. G. Davis Building	1110	Food Services		100		Cafeteria	471.9

Existing Physics Teaching Lab Floor Plan



Project Renovation Area