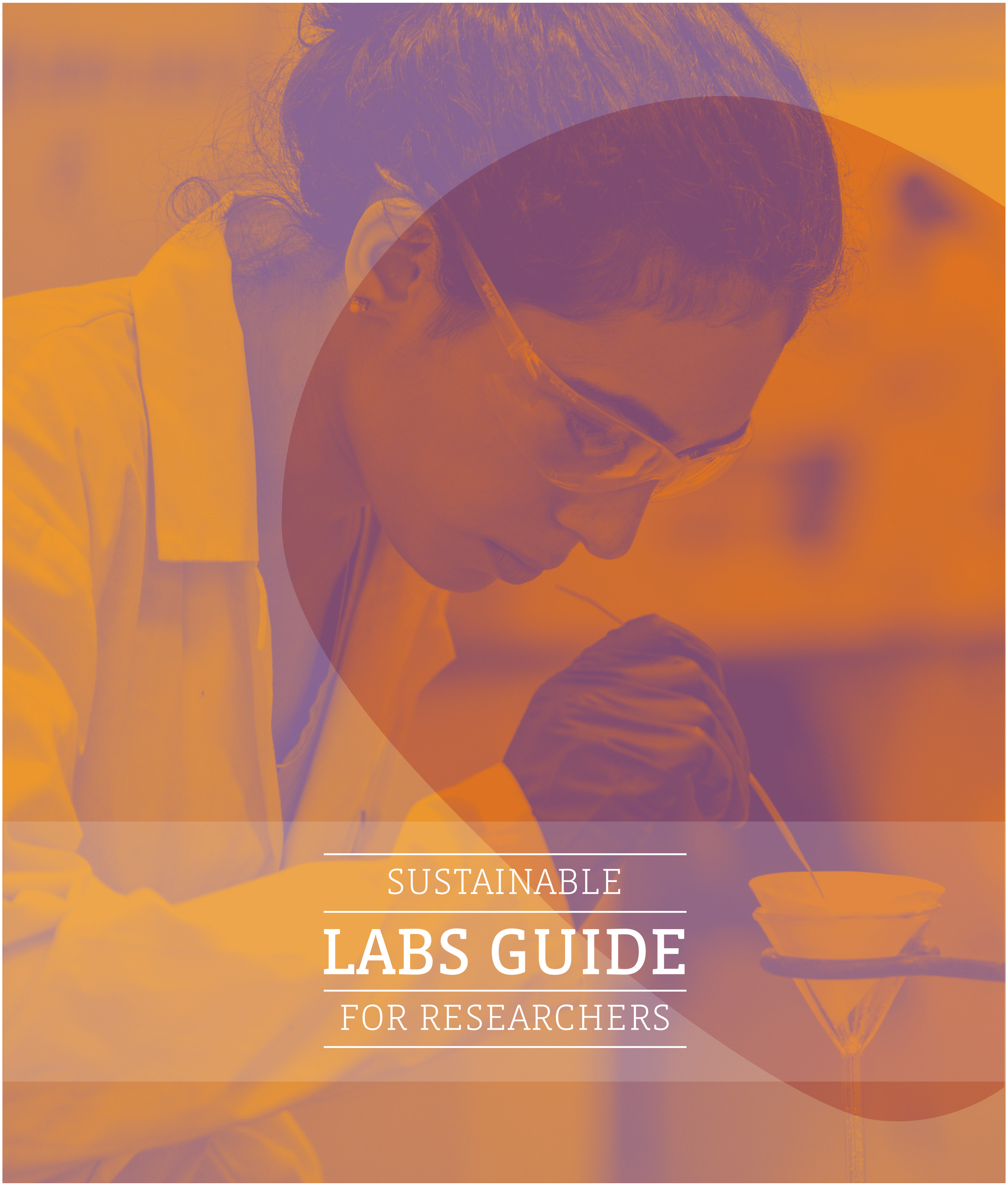

SUSTAINABLE LABS GUIDE FOR RESEARCHERS

McGill

SUSTAINABILITY AT MCGILL

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INTRODUCTION

The Sustainable Labs Working Group (SLWG) was created in October of 2014 with a mandate to include sustainability considerations in lab processes. The working group consisted of students, staff, and faculty from across the university.[1] As a result, this guide was developed for the benefit of those working in laboratories and those whose work supports laboratory operations. The vision of the SLWG was to:

> *"Engage the University community; promote and recognize efforts to reduce material, water, and energy consumption while maximizing cost savings; improve safety and accessibility through optimizing operations, training and awareness."* [2]

The SLWG was established in alignment with "Action 3 - Sustainable labs" [3] of the University's Priority Actions for the Vision 2020 Sustainability Strategy (approved in spring of 2014).

This guide was approved by the University Lab Safety Committee in October 2016.

[1] See appendix for a complete list of invited participants
[2] Approved by the SLWG January 30, 2015
[3] See appendix Action 3: Sustainable Labs

SAFETY AND SUSTAINABILITY INSPECTION CHECKLIST

The “Laboratory Safety Inspection Work Form” has been updated to include a section dedicated to sustainability, which consist of six checklist items. Those new items will not affect the overall score of the inspection. They will only be used to collect data for McGill’s Office of Sustainability (MOOS). MOOS will also use items that were already in the checklist for their statistics, so those will still count in your actual laboratory inspection score. The new sustainability items are:

Green Chemistry

Prevent use of damaging chemicals where greener alternatives are available for intended use. Common examples are:

- Ethidium bromide vs Sybr-safe
- Halogenated solvents vs non-halogenated
- Mercury thermometers vs alcohol based thermometer
- Scintillation fluid included in the HWM approved list

If not in this list, the PI can provide the EHS inspector with an example of green chemistry in their lab that is specific to their research. Use the “Additional Comments” section of the checklist to that effect.

Resource Efficiency

The EHS inspector will be looking for:

- Leaky faucet
- Running tap when not in use
- Using city water for cooling systems or letting city water run continuously

Issues that pertains to Facilities Management will not be considered if the inspector is provided with a service call work order number

Environmental Handwashing Soap

Soap must not contain microbeads, triclosan or any other known polluting agent.

Pi Sharing Chemicals

The “share chemical” functionality is activated in the myLab chemical inventory module.

Efficient Use of Equipment

As there is no official certification for energy efficient laboratory equipment (e.g., Energy Star is for consumer products only), the inspector will look for efficient use of laboratory equipment, including (but not limited to):

- Refrigerator/freezer half full (potential to be reorganized)
- Refrigerator/freezer heat dissipation coil clogged with dust
- Refrigerator/freezer not defrosted (more than ½ inch, frost preventing proper door seal, coil frosted)
- Equipment powered on when not in use (hot plates, shakers, cooling bath, etc.)
- Fume hood (sash closed)
- Other relevant equipment

Equipment that belongs to the University (e.g.: fume hood) will be assessed for statistical purposes only.

Recycling Bins Available

The inspector will verify if the laboratory is equipped with recycling bins, and if the segregation is done properly.

BEST PRACTICE

ENERGY

Research labs are generally energy guzzlers. Many applications require high ventilation rates to ensure lab users' safety, which results in significant energy consumption. Labs found at McGill consume four times as much energy per square foot as a typical Canadian household. While part of this energy usage is unavoidable to support McGill's research mission, best practices can help labs be more efficient and environmentally friendly.

Fume Hoods

Fume hoods are used to contain potentially harmful byproducts of experiments conducted inside the hood to ensure a safe working environment for all lab users. Unless somebody is working under the hood, the sash should be shut at all times to properly contain substances while ensuring only the necessary airflow is exhausted from the lab. A fume hood with a sash opening of 50% 24/7 will consume the equivalent energy of four typical Canadian households in a year. Awareness campaigns on campus demonstrated proper hood management can reduce energy use by 80%, depending on the type of hood, ventilation system, and lab set-up.

Convert Unused Fume Hoods To Dormant State (Save $2,500 Per Hood Per Year)

A lab fume hood, even when the sash is down, will still exhaust substantial air volumes. If there is a hood left unused in your lab for long periods of time (more than six months), you can contact Facilities who will assess the situation. Depending on the type of hood, ventilation system and lab set-up, Facilities can temporarily decommission your hood. Hood decommissioning allows the complete shutdown of the hood and prevents people unaccustomed to the lab from using it and exposing themselves to potentially harmful chemicals while maintaining appropriate level of ventilation in the lab. This change can potentially save up to $2,500 per hood per year to the University and is reversible: the hood can be recommissioned at the request of the researchers.

BEST PRACTICE

Cold Storage

There are more than 1,000 freezers and refrigerators on campus. The least efficient ultralow temperature freezers can consume as much as half the energy of a typical Canadian household in a year. Cooling equipment exhausts warm air into the room that adds to the cooling load of the building, puts a strain on building systems, and can result in uncomfortable working conditions for lab users. Best practices include:

- **Purchase energy efficient equipment.** The upfront cost might be a little higher but the University will save money over the lifetime of the appliance.
- **Proper and regular maintenance.** This includes defrosting freezers regularly to avoid frost build-up and cleaning the coil at the back of appliances to avoid dust build-up. Frost and dust build-up greatly reduce heat exchange inside and outside the appliance and force the compressor to work more to reach the desired set point which reduces the lifespan of the appliance. To facilitate maintenance, portable freezers are available in the McIntyre Medical, Life Sciences, and Stewart Biology buildings. Contact your building director to borrow the freezer.
- **Room-temperature and dry-DNA storage** is an alternative to freezing samples. A project funded by the Sustainability Projects Fund and spearheaded by Prof. Newkirk demonstrated the viability of green bio-banking at McGill.
- **Sharing facilities.** Shared cold rooms offer many benefits over separate appliances: better energy performance, back-up emergency power, heat recovery, and more efficient use of space (storage capacity to footprint ratio).



Phantom Load

Most research equipment uses energy to some degree, whether electricity (ovens, incubators, microscopes, etc.) or steam (autoclaves). Best practice dictates that equipment should be turned off and not be left idling. Appliances requiring warm-up time should be turned on in the morning and turned off when researchers leave the lab at the end of the day. A good trade-off is to turn them off when leaving the lab and switch them back first thing in the morning. The use of power bars is recommended as an easy way to turn equipment on or off quickly and efficiently.

Water: Once Through Cooling

Once-through water-cooled systems are prohibited by municipal by-laws. Systems must either be connected to the building's central chilled water distribution or be equipped with a cooling unit powered by electricity despite the fact that these compliant systems consume more energy.

Other Information

Most labs at McGill are equipped with occupancy sensors to modulate temperature set points and ventilation flow rates depending on occupancy while staying within acceptable parameters. Sensors are also used to turn off the lights automatically in unoccupied space.

BEST PRACTICE

PROCUREMENT – 4RS

Because of the large quantities of goods and services required to conduct its research, teaching and learning activities, McGill University has identified the mainstreaming of Sustainable Procurement as a key objective. While Procurement Services is leading this initiative, everybody in a position to spend University funds (including research funds) should seek to understand and take account of the social, environmental and ethical impacts of their purchases. Please apply the 4-R hierarchy (rethink, reduce, reuse, recycle) before any purchase, and apply lifecycle thinking when selecting research equipment or laboratory supplies. Here are some of the key questions to ask yourself before any purchase:

- Does anybody else have this? Can I borrow it from someone?
- Can I use less of this or share with colleagues?
- Who makes this, where does it come from? How reputable is the supplier?
- How long will this last? Can it be repaired or upgraded in the future?
- How much energy does this model consume in comparison to other models?
- Can I find a model with less toxic components or contents?

For additional guidance on the sustainable purchase of goods and services at McGill, please consult:
https://www.mcgill.ca/procurement/sustainability

GREEN CHEMISTRY

When developing experiments, consider the 12 principles of green chemistry. One important facet to consider is if you develop a great experiment it will be reproduced and possibly scaled. Early careful consideration will help avoid long term effects of harmful chemicals. As further motivation, if a green method doesn't exist, by developing one, you will have an extra edge of novelty in your work.

MIT has developed a useful guide for green chemical alternatives. Some commonly-found chemicals with greener alternatives include:

- Ethidium bromide
- Halogenated solvents
- Mercury-containing equipment
- Solvent-based scintillation fluid (refer to selection chart)

3D PRINTERS

There are several types of 3D printing techniques. Assess the hazards and risks associated with the chemicals (VOCs and leachate -ABS etc.) and methods you are using. Always follow manufacturer's guidelines to use, including ventilation requirements.

- Melted plastics can emit volatile organic compounds and nanoparticles which can be inhaled
- The heated tip can reach several hundred degrees Celsius which poses a burn hazard
- If using a needle type printer, there is a risk of puncture and injection
- If printing with cell cultures, there are biohazard risks

BEST PRACTICE

LEAN IN THE RESEARCH LAB

The Lean system has its roots in postwar Japan to maximize use of limited resources in industry. For the last two decades it has been making inroads into other environments, including hospitals, government (e.g. *Directeur de l'état civil*) and labs (e.g. WHO, CDC). Some facts about Lean:

- Focus is on sustainability and productivity
- Lean has two components: philosophy and methodology
  - Workers are engaged in solving procedural and quality problems to provide value to the organization
  - Pursuit of continuous improvement through iterative improvements
  - Problems should not be blamed on specific persons – they probably lie in faulty or ambiguous **work processes**
- Lean is meant to facilitate workers' efforts in generating value for clients and is not a means of eliminating jobs

The "8 Wastes" in Lean:

1. **Transport** of items or documents
2. **Inventory** includes people in line, samples waiting to be analyzed, paper taking up space on someone's desk
3. **Movement/Searching:** "Knowledge workers spend 30% of their time searching data they need, unsuccessfully half the time."[4] If information is hard to find, it's waste - moving too much to get things accomplished is also wasteful
4. **Waiting** for instructions, approvals, raw materials
5. **Overproduction** is essentially doing today what you could do tomorrow or producing in excess of need – overproduction can increase wait times and inventory
6. **Over processing:** Examples include too many redundant approvals; creating a high quality output when a lesser quality is acceptable
7. **Defects** include mistakes or failures leading to rework or corrective measures
8. **Skills:** Missed opportunities to train and teach someone to do things properly or to collect their ideas for the greater good

Lean and continuous improvement tactics are typically common sense approaches such as the 5S method for organizing, Kanban (card) inventory management, mistake-proofing and visual management tools.

Training for staff is available to administrative staff through HR's Organizational Development unit's "LEAN - Process and Problem Solving Methodology" module.

Peer coaching and one-page "cheat sheets" on continuous improvement tools are available through the Micro-Process Improvement initiative on Yammer (login required with McGill email and password). A case study is available here. This volunteer group is willing to field questions and discuss specifics.

SUSTAINABILITY IN YOUR WORKPLACE AND EVENTS

McGill has a green workplace checklist and sustainable events guide for those who wish to take sustainability principles beyond the lab environment. Contact sustainability@mcgill.ca for more information.

[4] *Redmond, Thomas C. Data Driven: profiting from your most important business asset (Boston, MA: Harvard Business School Publishing, 2008), pg. 41*

ACCESSIBILITY AND UNIVERSAL DESIGN

The term "accessibility" encompasses principles of universal design (e.g. accessibility to those with disabilities): literal and perceived barriers should be reduced in order to increase representation of students with disabilities in fields that work in labs.

As written in the Checklist for Making Science Labs Accessible for Students with Disabilities (2014):

> All students should be able to safely access science laboratories, but the physical layout of standard lab design does not accommodate users with a range of abilities. Applying the principles of universal design – "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Center for Universal Design, 1997)[5]– during the design and construction phases of these spaces would significantly improve the accessibility of laboratories. The use of universal design, however, may not entirely eliminate the need for individual accommodation for persons with disabilities, depending on the type of science lab, course (such as biology or chemistry), impact of the disability, and environment.[6] Supporting the independence and inclusion of persons with disabilities in the laboratory may also require practical assistive solutions.[7,8]

McGill's Office for Students with Disabilities has resources on Universal Design principles here including application of Universal Design in teaching and learning.

[5]The Principles of Universal Design. NC State University.
[6]Disabilities, Opportunities, Internetworking, and Technology. (2013). Science labs.
[7]Council of Ontario Universities. (2014) Checklist for Making Science Labs Accessible for Students with Disabilities.
[8]Hilliard, L., Dunston, P. , McGlothin, J., and Duerstock, B. (2011). Designing beyond the ADA – Creating an accessible research lab for students and scientists with physical disabilities. Institute for Accessible Science: Purdue University.

RELEVANT McGILL POLICIES

McGill's Administrative Handbook provides guidance to McGill policies, procedures and guidelines, including building policies and regulations, financial policies and regulations, health and safety, environmental and sustainability policies and other applicable guidelines. Selected excerpts are below:

Environmental Policy and Principles
Paper Use Policy
Sustainability Policy
Procurement Policy
Field Work Safety
Laboratory Safety Manual
Asset Management Policy (in development)
Guideline for Disposal of Major Research Equipment
Guide to End of Life Equipment and Materials
IT Asset Management Regulation
Policy on the Responsible Use of IT Resources

REFERENCES, USEFUL RESOURCES, AND BEST PRACTICES

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Harvard University. Harvard University Sustainability, "Harvard University Green Labs Guide": http://green.harvard.edu/programs/green-labs

International Institute for Sustainable Laboratories (I2SL): http://www.i2sl.org/

Materials Research Facilities Network : http://www.mrfn.org/

Massachusetts Institute of Technology, Green Committee, "Green Your Lab": http://web.mit.edu/workinggreen/buy/lab.html

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Sustainable Labs Canada: http://slcan.ca/

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University of California Santa Barbara. "Shared Instrumentation": http://www.sharedinstrumentation.ucsb.edu/

Wittenberg, Rüdiger and Cock, Matthew J.W. (editors). *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices*. Global Invasive Species Programme (2001). http://www.issg.org/pdf/publications/gisp/guidelines_toolkits_bestpractice/wittenberg&cock_2001_en.pdf

[8] The Materials Research Facilities Network is a nationwide partnership of the Shared Experimental Facilities (SEFs) supported by the National Science Foundation's Material Research Science and Engineering Centers (MRSECs). The MRFN is designed and operated to provide support to researchers and experimental facilities engaged in the broad area of Materials Research in academic, government and industrial laboratories around the world.

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