Michigan Green Labs Initiative

Lab Assessment Packet

Version 1.0

July 31, 2013

Michigan Green Labs Initiative

Lab Assessment Packet

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A. Program Summary

Introduction

Welcome to the Michigan Green Labs Initiative (MGLI). You are about to begin a process of assessing the practices of your laboratory to find opportunities to recognize and improve environmental best practices. You will be joining a network of labs implementing green labs practices and striving for continuous improvement.

This packet will take you through an assessment process and provide resources for you to green up.

Purpose

Laboratories have been identified as a major opportunity for environmental improvement on campuses and in institutions. For example, labs are energy intensive, using 5 to 10 times more energy per square foot than an average office building (reference). Fortunately, there are ways to improve efficiency and reduce energy use. The U.S. EPA's Laboratories for the 21st Century (Labs21) program estimates that most labs can reduce energy use by 30 to 50%. A key step towards identifying savings is to assess how efficiently your lab uses energy.[1] This is a key principle behind the Michigan Green Labs Initiative – the self-assessment and continuous improvement process.

The overall purpose of the project is to jumpstart green labs programs in partner institutions, and also to have as many labs as possible working to implement green labs practices in their everyday operation.

MGLI Principles:

- Source reduction and pollution prevention
- Material reuse and recycling
- Energy efficiency and water conservation
- Greener product sourcing
- Toxics use reduction and green chemistry
- Hazardous substance substitution
- Micro-scale analytics

The MGLI focus is to facilitate the implementation of pollution prevention and energy conservation best practices and techniques without compromising the safety or integrity of laboratory research.

Program Summary

The MGLI goal is to transfer green labs best practices into individual laboratories as efficiently as possible, while tracking, estimating, and reporting results. Setting goals to incorporate best

practices is an important part of the process. The transfer of practices into individual labs will be accomplished through a self-assessment process. The purpose of this laboratory self-assessment is to:

1. Identify environmental improvement opportunities.
2. Introduce best practices and methods for source reduction, and efficient use of energy, water, chemicals, and materials.
3. Facilitate the implementation of recommended sustainability-focused techniques.

After a successful self-assessment, a lab may be recognized and certified at different levels based on practices and achievements.

Certification benefits for laboratories and institutions may include:

- Reduced pollution and a cleaner environment
- Achieve institutional sustainability goals
- Track and estimate environmental performance results
- Improved safety for laboratory personnel
- Reduction in operational expenses
- Increased grant application competitiveness
- Community recognition

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B. Green Labs Self-Assessment Process Overview

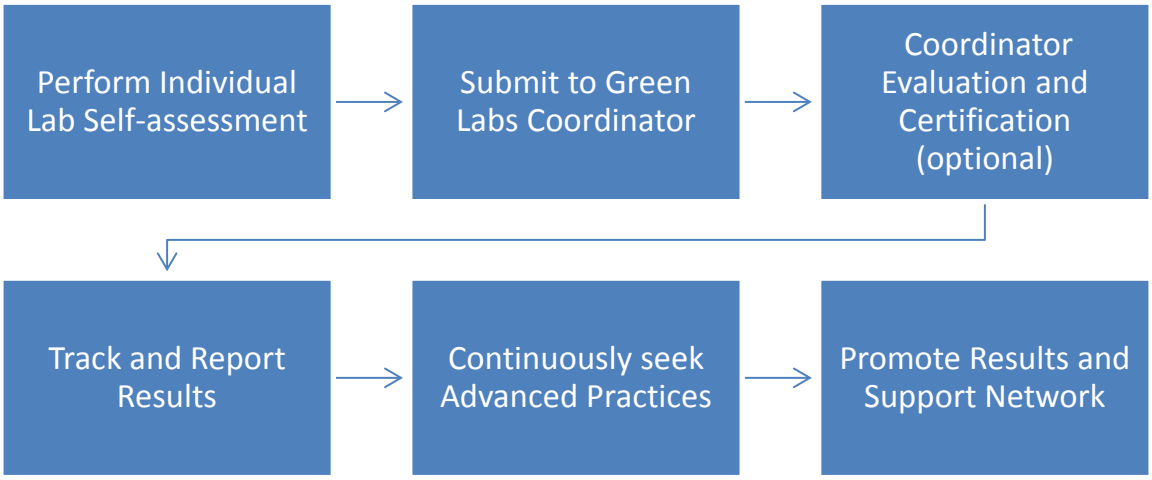
To facilitate the evaluation and possible certification of your laboratory, please follow the steps below to ensure your lab is properly evaluated and eligible for recognition.

Laboratory Self-Assessment, Certification, and Continuous Improvement Process:

1. Complete all fields in the self-assessment form with the most accurate and complete information possible.
2. Review your form with laboratory personnel to ensure the information is correct.
3. Optional – submit the self-assessment packet to your institution's green labs coordinator. Communicate with your institution's green labs coordinator to schedule a follow-up evaluation and possible certification.
4. Select and implement operational enhancements and environmental goals based on self-assessment and research to achieve desired certification level.
5. If needed, report newly adopted practices to your green labs coordinator for review and new certification.
6. Track, estimate, and report results and adopted practices using the Performance Measurement and Tracking form in this packet and submit to your green labs coordinator over agreed time period.
7. Seek continuous improvement opportunities to enhance green lab practices.

There is a reference document included in this lab assessment packet that includes a reference for each section of the self-assessment document. Please use the reference to learn more about each topic and to inform your actions as you move through the assessment, certification, and continuous improvement process.

Green Labs Self-Assessment Process at a Glance



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C. Self-Assessment Form

INTRODUCTION

Thank you for volunteering to participate in the Michigan Green Labs Initiative (MGLI)! You are on a path to becoming a more sustainable lab.

The MGLI is an effort dedicated to promoting sustainability within academic and institutional laboratories. The MGLI strives to facilitate the implementation of pollution prevention and energy conservation best practices and techniques without compromising the safety or integrity of laboratory research.

Laboratories have been identified as a major opportunity for environmental improvement on campuses and in institutions. For example, labs are energy intensive, using 5 to 10 times more energy per square foot than an average office building. Fortunately, there are ways to improve efficiency and reduce energy use. The U.S. EPA's Laboratories for the 21st Century (Labs21) program estimates that most labs can reduce energy use by 30 to 50 percent. A key step towards identifying savings is to assess how efficiently your lab uses energy. This is the key principle behind the MGLI self-assessment process.

The purpose of this laboratory self-assessment is to:

1. Identify areas for environmental improvement.
2. Introduce best practices and methods for source reduction and efficient use of energy, water, chemicals, and materials.
3. Facilitate the implementation of recommended sustainability-focused techniques.

MGLI Principles

- Source reduction and pollution prevention
- Material reuse and recycling
- Green product sourcing
- Toxics use reduction and green chemistry
- Hazardous substance substitution
- Micro-scale analytics

Post-Certification Benefits For Laboratory

- Reduced pollution and a cleaner environment
- Improved safety for laboratory personnel
- Reduction in operational expenses
- Increased grant application competitiveness
- Community recognition

SELF-ASSESSMENT PROCESS

To facilitate the assessment, evaluation, and certification of your laboratory, please use the following steps to ensure your lab is properly evaluated and eligible for recognition.

1. Complete all fields in the following pages with the most accurate and complete information possible.
2. Review your application with laboratory personnel to ensure the provided information is correct.
3. Return this application to your institution's sustainability office or green labs coordinator.
4. Await communication from a green labs representative to schedule a follow-up evaluation.
5. Select and implement operational enhancements and environmental goals.
6. Report results and adopted practices to your green labs representative for review.
7. Upon successful implementation, receive recognition and certification.

C. Self-Assessment Form

There is a reference document included with this checklist with information for each section of this self-assessment document. Please use the reference to learn more about each topic and to inform your actions as you move through the assessment process.

CONTACT INFORMATION

Date _____

	Primary Contact		Laboratory Manager / Principal Investigator
Name	_____	Name	_____
Email	_____	Email	_____
Phone	_____	Phone	_____
Office	_____	Office	_____

LABORATORY DETAILS

Laboratory _____

Department _____

Institution _____

Building/Address _____

Room Number(s) _____

LABORATORY ACTIVITY

Description of research, operations, techniques, etc.

C. Self-Assessment Form

GENERATED WASTE STREAMS

Example high cost waste streams are listed below. Indicate if any are used or generated. These items should be targeted for waste reduction opportunities. Treatment and disposal recommendations are provided in the reference document.

☐ Acids	☐ Hydroperoxides	☐ Metal fluorides in aqueous soln.
☐ Acid halides and anhydrides	☐ Inorganic cyanides	☐ N-nitroso compounds
☐ Aldehydes and ketones	☐ Mercaptans, carbon disulfide	☐ Oxidizers
☐ Alkyl halides	☐ Metal azides	☐ Phenol
☐ Aromatic amines	☐ Metal bearing aqueous solns.	☐ Mercuric compounds

Below, record generated waste streams, including type, amount, frequency, costs, etc. See reference document for waste stream identification techniques.

HIGH PRIORITY EQUIPMENT

Survey laboratory for the following equipment types and record any instances in the Inventory Identification document. After assessment, for all applicable items, review High Priority Items section of reference guide for efficiency-maximizing opportunities.

☐ Autoclaves	☐ Biosafety Cabinets	☐ Centrifuges
☐ Chromatographs	☐ Cryo-coolers	☐ Dri Baths
☐ Environmental Room	☐ Glass Washers	☐ Growth Chambers
☐ Heat Blocks	☐ Incubators	☐ Ovens
☐ Refrigerators and Freezers	☐ Spectrometers	☐ Temp. Controlled Rooms
☐ Thermal Cyclers	☐ Vacuum Pumps	☐ Ventilated Cage Racks
☐ Water Baths	☐ Circulation Chillers	☐ Lasers & Radioactive Imagers

C. Self-Assessment Form

Questionnaire and Checklist

For checklist items below, review current practices, then answer "YES"," NO", or "N/A" if they are being implemented. Refer to the reference document for further information on best practices. When you have completed the checklist, you can review your answers and set goals to turn your "NO" answers into "YES".

ENERGY CONSERVATION

1. Equipment and Operations		YES	NO	N/A
Essential Items				
1.1	Are computers and monitors set to automatically enter sleep mode after a period of inactivity? Are computers and monitors shut down when not in active use?	☐	☐	☐
1.2	Are electrical and mechanical units maintained and powered off when not in use?	☐	☐	☐
1.3	Is heating equipment properly maintained and turned off when not in use?	☐	☐	☐
1.4	Are fume hoods closed and set to the minimum ventilation rate when unattended?	☐	☐	☐
Advanced Items				
1.5	Are freezers, refrigerators, and common access storage in a centralized location?	☐	☐	☐

2. Refrigeration		YES	NO	N/A
Essential Items				
2.1	Are all freezers, except those that store biological tissues set to ≥ -70°C?	☐	☐	☐
2.2	Are freezers clear of potential fire starters and/or storage of reactive agents?	☐	☐	☐
2.3	Is freezer and refrigerator space consolidated to obtain maximum capacity?	☐	☐	☐
2.4	Is space in a cold room available as an alternative to a refrigerator?	☐	☐	☐
2.5	Have you ensured incubators are not being used as refrigerators?	☐	☐	☐
2.6	Are refrigerator seals surveyed for separation periodically?	☐	☐	☐

3. Utility Use		YES	NO	N/A
Essential Items				
3.1	Are lights in unoccupied areas powered off?	☐	☐	☐
3.2	Are thermostat controlled environments set to a maximum of 70°F?	☐	☐	☐
3.3	Are air-conditioned environments set to a minimum of 75°F?	☐	☐	☐
3.4	Have incandescent light bulbs been removed from the lab and replaced with CFL or LED?	☐	☐	☐
3.5	Have you ensured that space heaters or fans are not being used to heat or cool the lab?	☐	☐	☐
3.6	Are windows and doors kept closed (especially to the outside)?	☐	☐	☐
Advanced Items				
3.7	Are steam and hot liquid channels insulated?	☐	☐	☐
3.8	Are switches consolidated to control larger sets of lights?	☐	☐	☐
3.9	Are utility bills regularly reviewed and tracked to gauge total energy consumption?	☐	☐	☐

WATER CONSERVATION

4. Water Conservation		YES	NO	N/A
Essential Items				
4.1	Are all units that receive or dispense water regularly checked for leaks?	☐	☐	☐
4.2	Are low gauge facets in place (2 gallons/minute)?	☐	☐	☐
4.3	Have any open/single-pass cooling or heating systems been replaced with a closed system?	☐	☐	☐
4.4	Is washing equipment run only when at full capacity?	☐	☐	☐
4.5	Are pipettes cleaned using wash racks rather than a “fill and rinse” system?	☐	☐	☐
Advanced Items				
4.6	Are high efficiency vacuum pumps used instead of water aspirators, where possible?	☐	☐	☐

POLLUTION PREVENTION AND WASTE REDUCTION

5. Recycling		YES	NO	N/A
Essential Items				
5.1	Are electronic and battery waste products segregated and recycled?	☐	☐	☐
5.2	Are papers, cardboard, and packaging waste products segregated and recycled?	☐	☐	☐
5.3	Are recycling receptacles clearly labeled/designated and easily accessible?	☐	☐	☐
5.4	Are recycling and waste management procedures established and conducted?	☐	☐	☐
5.5	Are efforts made to recycle and unsubscribe from unwanted mail?	☐	☐	☐
5.6	Do appropriate devices use rechargeable batteries?	☐	☐	☐
Advanced Items				
5.7	Is there a shared supplies bank with other labs that limits wasting surplus quantities of materials?	☐	☐	☐
5.8	Have you examined all products used in the lab for recyclability?	☐	☐	☐

6. Waste Reduction		YES	NO	N/A
Essential Items				
6.1	Are printers/copy machines set to print double sided by default?	☐	☐	☐
6.2	Are gas cylinders secured and their regulators surveyed for leaks?	☐	☐	☐
6.3	Are documents and information available digitally instead of printing?	☐	☐	☐
6.4	Are chemical inventories routinely reviewed and maintained?	☐	☐	☐
6.5	Are chemical supplies used on a first-in, first-out basis?	☐	☐	☐
6.6	Are waste stream accumulation areas located near the end of processes?	☐	☐	☐
Advanced Items				
6.7	When possible, are procedures miniaturized or computationally simulated?	☐	☐	☐
6.8	Does the lab rent, lease, or share extra quantities of purchased materials?	☐	☐	☐

7. Waste Disposal and Treatment		YES	NO	N/A
Essential Items				
7.1	Are chemical containers clearly labeled and identifiable?	☐	☐	☐
7.2	Are designated waste containers closed and sealed?	☐	☐	☐
7.3	Is acid waste neutralized before disposal?	☐	☐	☐

GREEN PURCHASING AND GREEN CHEMISTRY

8. Environmentally Preferred Products		YES	NO	N/A
Essential Items				
8.1	Are nontoxic and biodegradable products purchased when possible?	☐	☐	☐
8.2	Have you taken all possible steps to eliminate mercury-containing products?	☐	☐	☐
8.3	When available, are Energy Star rated products purchased?	☐	☐	☐
Advanced Items				
8.4	If there are PVCs, BPA, PBTs, or phthalate containing products present, have you taken steps to identify, remove, and discontinue future purchasing?	☐	☐	☐

9. Greener Chemicals and Materials		YES	NO	N/A
Essential Items				
9.1	Have you reviewed the principles of green chemistry and engineering and shared with all laboratory personnel?	☐	☐	☐
Advanced Items				
9.2	Have you reviewed processes and procedures for toxics use reduction opportunities?	☐	☐	☐
9.3	Have you reviewed chemicals and materials used in the lab for less hazardous substitutes and safer alternatives?	☐	☐	☐

Examples of Common Hazardous Chemicals

Please identify the use of any of the following example materials considered environmentally hazardous. For each item checked, refer to the reference guide to research for alternative sources.

☐ Acetamide	☐ Benzene	☐ Benzoyl peroxide
☐ Carbon tetrachloride	☐ Chromate ion	☐ Formaldehyde
☐ Formalin	☐ Mercuric chloride	☐ Sulfide ion
☐ Toluene	☐ Xylene	☐ Ethidium bromide

C. Self-Assessment Form

EDUCATION AND COMMUNICATION

10. Education and Communication		YES	NO	N/A
Essential Items				
10.1	Does orientation for new lab personnel teach safety and sustainability best practices?	☐	☐	☐
10.2	Are lab meetings that reinforce sustainability practices hosted regularly?	☐	☐	☐
Advanced Items				
10.3	Have you searched the Greener Education Materials Database and the Michigan Green Chemistry Clearinghouse for greener laboratory exercises and curricula?	☐	☐	☐
10.4	Have you researched micro-scale techniques for reducing materials use during laboratory exercises and analytical processes?	☐	☐	☐

When you have completed all checklist questions, record the total number of respective responses below.

	YES	NO	N/A
Total Essential Items:	___	___	___
Total Advanced Items:	___	___	___

Now that you have made it through the checklist, refer to the "Measurements and Tracking" document. Record checklist items marked "NO" in the appropriate section. Use the goals section of the form to set actions. The objective is to answer "YES" on more basic and advanced items in the future. Remember to refer to the reference guide for useful information on best practices for the checklist items.

LABORATORY COMMITMENT

We, members of the laboratory using Michigan Green Labs Initiative assessment documents, affirm to the best of our knowledge that all of the above information is accurate and verifiable. We are aware of the environmental significance attributed to laboratory research on campus. Furthermore, we recognize the benefits of this assessment and pledge to adopt sustainable methods of a higher degree. We will strive to incorporate green labs best practices into laboratory operations and measure and track our results.

Lab Manager / Principal Investigator **Date (mm/dd/yyyy)**

Signatures of Laboratory Personnel (≥75% of personnel)

1.	**2.**	**3.**
4.	**5.**	**6.**
7.	**8.**	**9.**
10.	**11.**	**12.**
13.	**14.**	**15.**

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D. Green Labs Resources and Reference

How to Use this Resources and Reference Document

This resource is an informational supplement to the Self-Assessment Checklist. For each category or item in the checklist, you will find information to help you increase your sustainable practices in that focus area. If you answered "No" for any questions in the checklist, this guide provides information and links to help you answer "Yes" on a future evaluation. This reference also contains additional information on best practices beyond specific questions in the self-assessment checklist. The overall goal is continuous environmental improvement of your laboratory operations, and this resource will give you a window into the wide array of resources available.

This guide is best viewed electronically because it references numerous links on lab environmental best practices. Content in this reference has been pulled from resources available via the internet.

Contents

I. High Priority Equipment

Energy Equipment Laboratory Equipment Wiki
Labs for the 21st Century
http://labs21.lbl.gov/wiki/equipment/index.php/Energy_Efficient_Laboratory_Equipment_Wiki

Best Practices (autoclaves, centrifuges, heat blocks, refrigerators, freezers)
Labs for the 21st Century
http://labs21.lbl.gov/wiki/equipment/index.php/Best_Practices

II. Energy Conservation

Equipment and Operations

Green Laboratory Certification Resources – Energy Use
University of Washington
https://f2.washington.edu/ess/green-laboratory/resources#Water

Fume Hoods Provide Key to Laboratory Energy Savings
Pacific Gas & Electric Company
http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/biotech/fs_FumeHood.pdf

Shut the Sash Program
Harvard University
http://green.harvard.edu/shut-sash-program

Fume Hood Sash Stickers Increases Laboratory Safety and Efficiency at Minimum Cost
United States Department of Energy
http://www1.eere.energy.gov/femp/pdfs/sash_stickers_cs.pdf

Behavioral Changes in Laboratory Energy Consumption – Fume Hoods
University of California – Los Angeles
http://ehs.ucla.edu/Pub/Fall08_FumeHoodResults.pdf

Working with Water-Cooled Equipment - 7.B
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/n/nap12654/ch7/#ch7.s2

Working with Electronically Powered Laboratory Equipment - 7.C
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/n/nap12654/ch7/#ch7.s3

Refrigeration

Working with High or Low Pressures and Temperatures - 7.E
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/n/nap12654/ch7/#ch7.s57

Freezer Management Program
Harvard University
http://green.harvard.edu/freezer-management-program

Utility Use

Minimizing Reheat Energy Use in Laboratories
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_reheat_508.pdf

Optimizing Laboratory Ventilation Rates
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_opt_vent_508.pdf

General Resources

Energy Recovery in Laboratory Facilities
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_recovery_508.pdf

Laboratory Modeling Guideline using ASHRAE 90.1-2007 Appendix G
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/ashrae_appg_2007_508.pdf

Metrics and Benchmarks for Energy Efficiency in Laboratories
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_metrics_508.pdf

Efficient Electrical Lighting in Laboratories
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_lighting_508.pdf

Right-Sizing Laboratory Equipment Loads
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_rightsizing_508.pdf

Resource Conservation – Electricity (Page 9)
Alfred University
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

P2 for Analytical and Medical & Biological Labs (Page 10)
Alfred University
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

Working with Laboratory Equipment - 7
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/n/nap12654/ch7/

III. Water Conservation

Water Conservation

Green Laboratory Certification Resources – Water Conservation (Page 9)
University of Washington
https://f2.washington.edu/ess/green-laboratory/resources#Water

Resource Conservation - Water
Alfred University
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

Water Efficiency Guide for Laboratories
International Institute for Sustainable Laboratories
http://www.i2sl.org/documents/toolkit/bp_water_508.pdf

Switch to Pipette Wash Racks
University of California – San Francisco
http://campuslifeservices.ucsf.edu/upload/sustainability/files/Pipette_Washing_Racks_flyerFINALv2.pdf

IV. Pollution Prevention and Waste Reduction

Recycling

Green Laboratory Certification Resources – Recycling, Compost, and Waste Reduction
University of Washington
https://f2.washington.edu/ess/green-laboratory/resources#Recycling

Waste and Source Reduction

P2 in Waste Management (Page 7)
Alfred University
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

Microscale Chemistry Analytics
National Microscale Chemistry Center
http://www.microscale.org/about.asp

Waste Disposal and Treatment

Hazardous Waste Minimization
Environmental Health and Safety – University of Washington
http://www.ehs.washington.edu/epohazreduce/index.shtm

Bench Scale Waste Treatment (Page 8)
The Arizona Department of Environmental Quality - Pollution Prevention Unit, 1999
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

V. Green Purchasing and Green Chemistry

Green chemistry consists of chemicals and chemical processes designed to reduce or eliminate negative environmental impacts. The use and production of these chemicals may involve reduced waste products, non-toxic components, and improved efficiency. Green chemistry is a highly effective approach to pollution prevention because it applies innovative scientific solutions to real-world environmental situations. http://www.epa.gov/greenchemistry/pubs/about_gc.html

Environmentally Preferred Products and Methods

Green Product Purchasing
University of Washington
https://docs.google.com/spreadsheet/pub?key=0AkGOiuV06vtWdGxxaElZdEpSX2FIeGM0Y1lWX0Y1VHc&gid=0

Purchasing and Inventory (Page 3 & 5)
Alfred University
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

Green Chemistry for Every Laboratory - 5.B
International Institute for Sustainable Laboratories
http://www.ncbi.nlm.nih.gov/books/NBK55868/#ch5.s2

Acquisition of Chemicals - 5.C
International Institute for Sustainable Laboratories
http://www.ncbi.nlm.nih.gov/books/NBK55868/#ch5.s15

Inventory and Tracking of Chemicals - 5.D
International Institute for Sustainable Laboratories
http://www.ncbi.nlm.nih.gov/books/NBK55868/#ch5.s18

Storage of Chemicals in Stockrooms and Laboratories - 5.E
International Institute for Sustainable Laboratories
http://www.ncbi.nlm.nih.gov/books/NBK55868/#ch5.s29

Transfer, Transport, and Shipment of Chemicals - 5.F
International Institute for Sustainable Laboratories
http://www.ncbi.nlm.nih.gov/books/NBK55868/#ch5.s38

Greener Chemicals and Alternatives

Common Chemical Substitutions (Page 4)
The Arizona Department of Environmental Quality - Pollution Prevention Unit, 1999
http://people.alfred.edu/~envhealthsafety/education/Lab%20Pollution%20Prevention_1999.pdf

Substitution of a More Hazardous Chemical by a Less Hazardous Chemical
Alfred University
http://contribute.alfred.edu/portals/ehs/docs/ChemicalSubstitutions.pdf

Green Alternative Wizard
Massachusetts Institute of Technology
http://ehs.mit.edu/greenchem/

Green Alternative Wizard Help Guide
Massachusetts Institute of Technology
https://ehs.mit.edu/site/sites/default/files/files/chem_alt_wiz_faq.pdf

Green Chemistry Assistant
St. Olaf College
http://fusion.stolaf.edu/gca/

Laboratory Resources
Michigan Green Chemistry Clearinghouse
http://migreenchemistry.org/education/laboratory-resources/

General Resources

Management of Chemicals - 5
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/NBK55868/

Green Chemistry Research and Engineering
United States Environmental Protection Agency
http://www.epa.gov/research/priorities/docs/GCFactSheet.pdf

University of California – Berkeley
http://bcgc.berkeley.edu/sites/default/files/InterdisciplinaryGreenChemistryCourseSyllabusFinal%20(4).pdf

VI. Education and Communication

Classroom Resources
Michigan Green Chemistry Clearinghouse
http://migreenchemistry.org/education/classroom-resources/

Greener Education Materials for Chemists
University of Oregon
http://greenchem.uoregon.edu/gems.html

Monograph on Green Chemistry Laboratory Experiments
Green Chemistry Task Force Committee, DST
http://www.dst.gov.in/green-chem.pdf

Green Laboratory Certification Resources – Communication and Education
University of Washington
https://f2.washington.edu/ess/green-laboratory/resources#Communication

Using Personal Protective, Safety, and Emergency Equipment - 7.F
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/n/nap12654/ch7/#ch7.s71

Emergency Procedures - 7.G
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/n/nap12654/ch7/#ch7.s94

VII. Green Labs Programs

Arizona State University
http://sustainability.asu.edu/about/resources/green-labs/index.php

Duke University
http://sites.duke.edu/greenlabs/
http://sustainability.duke.edu/action/certifications/labs/index.php

Emory University
(Additional Resource)
http://www.aashe.org/resources/student-research/green-labs-emory-university

Harvard University
http://green.harvard.edu/labs
http://green.harvard.edu/sites/default/files/harvard_university_lab_sustainability_guide_april_2013.pdf

Massachusetts Institute of Technology
http://ehs.mit.edu/site/content/laboratory-safety
http://web.mit.edu/workinggreen/buy/lab.html

Michigan State University
http://www.bespartangreen.msu.edu/greencert/

University of California – Berkeley
(Additional Resource)
http://bcgc.berkeley.edu/sites/default/files/InterdisciplinaryGreenChemistryCourseSyllabusFinal%20(4).pdf

University of California – Davis
http://sustainability.ucdavis.edu/action/green_workplace/green_labs.html

University of California - San Francisco
http://sustainability.ucsf.edu/get_involved/become_a_living_green_lab

University of California - Santa Barbara
http://www.sustainability.ucsb.edu/labrats/labrats-links/

University of California – Los Angeles
http://ehs.ucla.edu/Pub/Fall08_FumeHoodResults.pdf

University of Colorado – Boulder
http://www.colorado.edu/ecenter/greening-cu/cu-green-labs-program

University of Illinois – Chicago
http://www.uic.edu/depts/envh/

University of Maryland
(Additional Resource)
http://www.sustainability.umd.edu/documents/SSCC/Presentations/Laboratory%20Sustainability%20Developing%20a%20Green%20Labs%20Program.pdf

University of Michigan - Ann Arbor
http://www.ocs.umich.edu/labs.html

University of Nebraska
http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1100&context=envstudtheses

University of New South Wales
http://sustainability.unsw.edu.au/our-commitment/risk-and-compliance/green-lab-program
http://sustainability.unsw.edu.au/resources/green-lab-program
http://sustainability.unsw.edu.au/sites/all/files/resource_file/Adiministrator_Guide_BB_27-06-2011.pdf

University of Oregon
http://greenchem.uoregon.edu/

University of Pennsylvania
http://www.upenn.edu/sustainability/programs/green-labs
http://www.upenn.edu/sustainability/sites/default/files/Green%20Labs%20@%20Penn_0.pdf

University of Queensland
http://www.uq.edu.au/sustainability/green-labs-program

University of Texas
http://soa.utexas.edu/csd/symposia/campus_sustainability/PDFs/20_Nolan_LeBansky_Peterson.pdf

University of Vermont
http://www.uvm.edu/sustain/tags/green-labs
http://www.uvm.edu/safety/lab/green-laboratories-energy-savings-and-sustainability

University of Washington
http://f2.washington.edu/ess/green-laboratory
https://f2.washington.edu/ess/sites/default/files/green_lab/FINAL%20DRAFT%20NEWSLETTER%20REDUCED%20SIZE%20(2).pdf

Yale University
http://sustainability.yale.edu/tools-resources/certifications-we-offer/green-labs

VIII. Additional Resources

Green Chemistry Networks and Programs
Chemistry Resources Worldwide
http://www.chemistryguide.org/environmental-chemistry.html

Prudent Practices in the Laboratory
National Center for Biotechnology Information
http://www.ncbi.nlm.nih.gov/books/NBK55878/

Hazardous Laboratory Chemicals Disposal Guide
https://famnen.arcada.fi/lab/info/safety/waste%20management/Hazardous%20Laboratory%20Chemicals%20Disposal%20Guide%20-%20Armour%202003.pdf

NIH Labs Go Greener
National Institute of Health
http://www.nems.nih.gov/greening/Documents/factsheet_labs.pdf

Michigan Green Labs Initiative

Lab Assessment Packet - E. Inventory Identification and Documentation

Provide information in the following tables for equipment that your lab uses on a regular basis. List all non-identical items individually.

Fume Hoods

Unit #	Room #	Usage Description (Contents, Processes, Issues, etc.)	Usage Frequency	Type (CAV/VAV)	Do you keep fume hood closed while unattended and ventilation rate at lowest appropriate setting? (Y/N)	Are fume hoods shut off overnight? (Y/N)
1.						
2.						
3.						
4.						
5.						
6.						

Ventilation Canopies/Tubes

Unit #	Room #	Usage Description (Contents, Processes, Issues, etc.)	Usage Frequency	Type (Canopy/Tube)	Do you keep ventilation unit closed while unattended and ventilation rate at lowest appropriate setting? (Y/N)	Are ventilation units shut off overnight? (Y/N)
1.						
2.						
3.						
4.						
5.						
6.						

Michigan Green Labs Initiative

Lab Assessment Packet - E. Inventory Identification and Documentation

Biosafety Medical Storage

Unit #	Room #	Infectious Contents or Hazardous Agents	Ventilated (Y/N)	Vent Destination	UV Lighted (Y/N)	Is space consolidated in storage units and are unused units shut off? (Y/N)
1.						
2.						
3.						
4.						
5.						
6.						

Other Equipment

Refer to Self-Assessment document for other high priority items and record in table below. High priority items of interest include:

- Autoclaves
- Diffusion Pumps
- Electric Cold Traps
- Centrifuges
- Incubators
- Large Lasers & Motors
- Ovens
- Refrigerators & Freezers
- Roots Blowers
- Rotary Evaporators
- Pumps
- Radioactive Scanners

Please provide information in the following table for additional equipment or devices that your lab uses on a regular basis. Please list all non-identical items individually. For applicable items, please include set temperatures and/or rates in the comments section. For all items, evaluate whether they are being used efficiently, i.e. can the item be shut off or put on standby.

Item #	Item Type & Quantity	- Company / Brand - Model Number - Year of Manufacture	Power Usage (Amps/Volts/Watts)	Usage Frequency (Hours/Day)	Efficiently using item? (Y/N)	Comments	Insert relevant best practices from Reference Guide
1.							

2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							
13.							
14.							
15.							
16.							

Michigan Green Labs Initiative

Lab Assessment Packet

F. Performance Measurement and Tracking Form

The attached form should be utilized to inventory and quantify the actions and successes of Michigan Green Labs Initiative participants and measure the effectiveness of your pollution prevention activities. This information will not only highlight the achievements of your labs, but will also serve as a valuable measurement of overall effectiveness of Green Labs practices. Please review each of the following categories below that apply to your operations and summarize past results and new goals. Please indicate an N/A for those areas that are not applicable to your operations. (Insert additional rows or attach additional sheets as needed).

Step 1: Transfer applicable checklist items to this form for tracking and improvement. Define a repeatable time period for goals and results tracking.
Step 2: See reference material for baseline assessment and green labs best practices.
Step 3: Review goal setting information. Set aspirational goals to implement greener practices and continuously improve.
Step 4: If you have a green labs coordinator, submit this form when completed at agreed upon repeating time period.

Laboratory Details

Laboratory:	Building/Address:
Department:	Room Number(s):
Institution:	Time period (calendar/school year/other):

Performance Indicator	Goals	Results
Energy Conservation (Equipment and Operations, Refrigeration, Utilities)		
Energy Efficiency	*Example: 5% energy use reduction*	*Example: 50,000 kWh reduced*
Checklist Best Practice Items:	*Example: Implement fume hood best practices and monitor open sash time*	

Water Conservation		
Water Use Efficiency	*Example: 10% reduction in water consumption*	*Example: 140,000 gallons reduction in water consumption*
Checklist Items:	*Example: Install low gauge faucets and monitor water usage*	
Pollution Prevention and Waste Reduction		
Hazardous Waste Reduction	*Example: 15% reduction in hazardous waste generation*	*Example: 1,350 pounds reduced*
Solid Waste Reduction	*Example: 25% reduction in solid waste sent to landfill*	*Example: 2,600 pounds of cardboard, paper, and plastic recycled*
Checklist Items:	*Example: Remove all recyclable items from waste stream*	

Green Purchasing and Green Chemistry		
Materials Use Efficiency	*Example: 50% reduction in the use of solvents;* *Example 2: Replace five most hazardous substances used in lab with safer alternatives.*	*Example: 100 pounds of solvent reduced;* *Example 2: Substituted A, B, C substances for X, Y, and Z in the following volumes: __*
Checklist Items:	*Example: Review chemicals for safer and less hazardous substitutes*	
Education and Communication		
Checklist Items:	*Example: Implement new greener lab exercise and estimate reductions*	

Green Labs Program Influences and Behaviors

Do you have a:

☐ Green Labs Checklist ☐ Green team

Has your involvement with Green Labs led to:

☐ Increased awareness and knowledge of pollution prevention?
Explain:

☐ Implementation of new green labs initiatives/technologies?
Explain:

☐ Implementation of a green purchasing program?
Explain:

☐ The implementation of energy and water conservation programs?
Explain:

Has your involvement with Green Labs been beneficial to your lab?

☐ Yes ☐ No

Why?

Testimonials/Quotes/Photos: