MINNESOTA B3 GUIDELINES

New Buildings and Major Renovations

Version 3.1 Final Version

November 2018

Includes Updated Sections:

Site and Water

Indoor Environmental Quality

Center for Sustainable Building Research
College of Design · University of Minnesota

Print Version Contents

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All SB 2030 Documents Available at b3mn.org/2030energystandard

B3 Guideline Version History

The B3 Guidelines are required for projects funded directly or indirectly, in whole or in part, from Minnesota bond monies after January 1, 2004. The guidelines have been updated several times since the beginning of this program: Version 1.1 was the applicable version for new construction projects receiving bond money from 2004 to 2006. Version 2.0 followed for new construction projects receiving bond money prior to 2009. In 2009, Version 2.1 was released with the online B3 Guidelines Tracking Tool and the B3 Guidelines became mandatory for major renovation projects. After August 1, 2009, the Sustainable Buildings 2030 (SB 2030) Energy Standard became the energy efficiency requirement of the program. This standard included a focus on increasing efficiency requirements across a wide array of building types, and providing several paths to compliance.

In 2013, Version 2.2 was released, which included significant updates in the following areas:

- Site and water management
- Stormwater management
- Incorporation of bird-safe building design
- Process requirements reorganized (commissioning)

In 2017 version 3.0 was released and is applicable for projects that began schematic design on or after July 1, 2017 and which had not started predesign and begun tracking in the B3 Guidelines Tracking Tool by January 1, 2019.

The guidelines contained in this document comprise version 3.1 and are applicable for projects beginning predesign or enrolled in the B3 Guidelines Tracking Tool on or after January 1, 2019. Version 3.1 contains substantial revisions to the Site and Water and Indoor Environmental Quality Guideline Sections. Additional language was also added to clarify the minimum commissioning scope.

The B3 Guidelines build on previous regional and national efforts to achieve its goals: They are designed to be compatible with other national guidelines and rating systems while maintaining regional values, priorities, and requirements. They are also designed to be clear, simple, and easily monitored with explicit documentation to record progress. The B3 Guidelines set up a process for quantifying the human, community, environmental, and life-cycle economic costs and benefits of new projects and help to fully account for the actual costs and benefits of sustainable building design.

Guidelines Organization

The guidelines are organized into the following topic categories:

- Performance Management
- Site and Water
- Energy and Atmosphere
- Indoor Environmental Quality
- Materials and Waste

In this document, the guidelines are discussed according to category. Each category begins with the intent of that topic. Guidelines are noted as required or recommended, and each guideline is presented with specific intent, the required and recommended performance criteria, guidance on meeting the guideline, required Tracking Tool submissions, and additional resources, such as glossaries. This document also includes a list of project information collected by the B3 Guidelines Tracking Tool that does not correspond to specific guidelines.

Applicability

With the expansion of the legislation in 2008 to include major renovations, the two main types of projects subject to B3 Guidelines are New Buildings and Major Renovations. Each has their own criteria for required use.

New Buildings Overall Applicability Criteria:

All new buildings funded in whole or part by Minnesota bond monies after January 1, 2004 must comply with B3 Guidelines. Additions are considered New Buildings that require compliance with B3 Guidelines if they have both of the following characteristics:

- If heated, the addition has its own heating plant(s) (e.g., boiler, etc.) whether or not its source of energy (e.g., fuel) is from an adjacent building.
- If cooled, the addition has its own cooling plant(s) (e.g., chiller, rooftop unit, etc.) whether or not its source of energy (e.g., electricity) is from an adjacent building.

Exceptions to compliance with the B3 Guidelines as a whole are *not* allowed based on size of building, number of utility connections, or whether a building is heated, cooled or electrically lit. However, some individual guideline criteria are adjusted based on these or other variations.

If an agency or design team feels certain guideline criteria do not apply to a particular building due to programmatic conflict, this is handled through a variance process facilitated through the B3 Guidelines Tracking Tool.

Major Renovations Overall Applicability Criteria:

All Major Renovation work funded in whole or part by Minnesota bond monies after January 1, 2009 must comply with the guidelines. Renovation work is considered under Major Renovations and requires compliance with the guidelines if it has both of the following characteristics:

- Renovated area includes 10,000 square feet or more.
- It encompasses at least the replacement of the mechanical, ventilation, or cooling system of the building, or a section of the building.

Exceptions to compliance with the B3 Guidelines as a whole are *not* allowed based on number of utility connections, or whether the renovated area is heated, cooled, or electrically lit. However, some individual guideline criteria are customized based on these or other project characteristics. If an agency or design team feels certain guideline criteria do not apply to a particular building, this is handled through a variance process facilitated through the B3 Guidelines Tracking Tool. Exceptions are permitted if a Major Renovations project has completed its Design Development Phase before February 23, 2009 (when the guidelines for Major Renovations were released), and subsequently received new or additional bond funding after January 1, 2009.

Not-Applicable versus Not Compliant Status:

Any construction project that receives bond funding after January 1, 2004 which is believed to not be subject to the B3 Guidelines should complete a Non-Applicability Request Form (available from the B3 Project Website). This form is *not needed* if a project is following the B3 Guidelines. This form is used to determine whether the B3 Guidelines apply to a project and thus whether the project needs to meet the guidelines as a whole. Projects that have been granted a Not Applicable designation after completing this form will be noted by the B3 Guidelines Team but would not need to further pursue the guidelines, barring any project changes. Projects that are not following the guidelines and have submitted a Non-Applicability Request Form but have not yet received a Not Applicable designation will be listed as "pending" until status can be determined. If the B3 Guidelines Team determines that the B3 Guidelines do apply to a

bond-fund receiving project but the project is not following B3 Guidelines, that project will be listed as Not Compliant on the B3 Case Studies Database and in reporting to the state.

Once the B3 Guidelines Team has determined that a project must comply with the overall B3 Guidelines, renovation projects may still request exemption from specific guidelines. This is permitted for guidelines pertaining to work outside the scope of the renovation.

The table below distinguishes requirements for New Buildings from requirements for Major Renovations, while allowing reference to a common master set of guidelines. The table also lists which guidelines are required for different types of renovations.

	Guideline	New Buildings	Major Renovations
	Performance Management		
P.1	Design and Construction Process	Required	Required
P.2	Operations Process	Required	Required
	Site and Water		
S.1	Site and Water Connections	Required	Required for Minimum Site Scope (See Guideline)
S.2	Site Water Quality and Efficiency	Required	Required for Minimum Site Scope (See Guideline)
S.3	Soil	Required	Required for Minimum Site Scope (See Guideline)
S.4	Vegetation	Required	Required for Minimum Site Scope (See Guideline)
S.5	Animal Habitat Support	Required	Required for Minimum Site Scope (See Guideline)
	Energy and Atmosphere		
E.1	Energy Efficiency	Required	Required
E.2	Renewable Energy	Required	Recommended
E.3	Efficient Equipment and Appliances	Required	Required
E.4	Atmospheric Protection	Recommended	Recommended
	Indoor Environmental Quality		
I.1	Low-Emitting Materials	Required	Required for Newly Installed Materials
I.2	Moisture and Water Control	Required	Required if Exterior Envelope is in Scope
I.3	Ventilation	Required	Required
I.4	Thermal Comfort	Required	Required
I.5	Lighting and Daylighting	Required	Required
I.6	Effective Acoustics	Required	Required
I.7	View Space and Window Access	Required	Required
I.8	Ergonomics and Physical Activity	Required	Required
I.9	Wayfinding and Universal Access	Required	Required
	Materials and Waste		
M.1	Life Cycle Assessment of Materials	Required	Required (Partial - See Guideline)
M.2	Environmentally Preferable Materials	Required	Required
M.3	Waste Reduction and Management	Required	Required
M.4	Health	Required	Required

Some guidelines are not be applicable to some Major Renovation projects. Detail is provided under those guidelines. Guidelines without further detail on applicability may be assumed to be required for all project types.

Process

Compliance with the B3 Guidelines involves the coordination of several project team members across several phases. The primary guideline management roles, the guideline management process and the variance process are outlined below. This process must be completed through the B3 Guidelines Tracking Tool (at trackingtool.b3mn.org).

Guideline Management Roles

Work Team: The work team is the team responsible for advancing a project through the B3 Guidelines during each particular phase. Depending on the phase, the work team may include the planning team, predesign team, design team, construction team, or operations team. This team works toward achieving the guideline performance criteria appropriate to their phase. The work team is also responsible for completing all required documentation in the B3 Guidelines Tracking Tool at the end of each phase (and annually during ongoing occupancy for 10 years).

Guideline Leader: The guideline leader coordinates the completion and documentation of tasks to comply with the sustainable building guidelines. Different people may fill the role of guideline leader for each phase. The guideline leader may work within the organization contractually responsible for a specific phase, or he or she may be a consultant hired by that organization. The guideline leader is the primary contact person for guideline compliance. If an agency does not designate this role, a representative from the work team fulfills the guideline leader's tasks.

The guideline leader's duties include:

- Coordinating and supporting the Guideline Management Process.
- Maintaining continuity as the guideline leader's position transfers across phases and responsible organizations.
- Supporting an interdisciplinary, participatory team approach.

The guideline leader should possess the following qualities:

- Be familiar with B3 Guidelines and with sustainable building practices in general.
- Have good facilitation and communications skills.

Appropriated Agency: The appropriated agency is the agency that received funding from the capital bond proceeds on behalf of the project and is responsible for compliance review. The agency contact role is the representative of the appropriated agency and includes the following responsibilities:

- The appropriated agency is responsible for reviewing (but not necessarily determining) compliance with B3 Guidelines according to the Compliance Review Process based on the extent of compliance documented in the B3 Guidelines Tracking Tool.
- The appropriated agency reviews and decides whether to accept variance applications according to the Variance Review Process.
- The appropriated agency may choose to cease involvement in project compliance monitoring after successful completion of one year of operation.

CSBR: The Center for Sustainable Building Research (CSBR) at the University of Minnesota acts as the B3 Guidelines Tracking Team. CSBR leads the B3 Guidelines Tracking Process and updates and maintains project information with required forms and optional guideline reports for each phase of project development and each year of operational data. This data may be posted on the B3 Guidelines Case Study Database. It may also be used for selected audits, to improve the usability and effectiveness of the B3 Guidelines, and to translate building performance into state economic, human, and environmental outcomes. CSBR tracks the B3 Guidelines on direction of the state.

Project Planning & Work:

- At the start of each phase (or year of operation), the guideline leader reviews the B3 Guidelines and required documentation, plans the tasks to be completed for that phase to meet the guidelines, and communicates this with the work team.
- If variances to the B3 Guidelines are sought, the guideline leader requests a variance from the appropriated agency before completion of the Design phase of the B3 Guidelines Tracking Tool. This variance request is made for individual guidelines using the B3 Guidelines Tracking Tool and reviewed by CSBR prior to agency approval.
- The work team for the responsible organization (planning team, design team, construction team, or operations team depending on phase) incorporates B3 Guidelines requirements into the work.

Documentation:

- The work team completes the appropriate documentation via the B3 Guideline Tracking at the end of each phase. The team should archive relevant documentation for that phase (or for one year) for future reference.
- The guideline leader submits online documentation to the appropriated agency for compliance review at the end of each phase (or annually during facility operation).

Review and Tracking:

- The appropriated agency reviews the level of compliance reported by the work team. The agency also reviews and decides whether to approve variance requests.
- CSBR tracks the status of compliance, variances, documentation, and performance outcomes and summarizes these for the state.

B3 Guidelines Tracking Tool

All project information is submitted through the online B3 Tracking Tool. The Tracking Tool is an online project file that helps to collect information at each phase of the guidelines from team members and manages the submission process. Each guideline is assigned to an individual role in the tool, the individual assigned to that role should then complete the required information to document compliance with the B3 Guidelines. Once all information has been submitted for a specific phase, the guideline leader submits the phase to be reviewed either by the agency contact or by the SB 2030 reviewer and the agency contact (the SB 2030 review takes place after the Design and Final Design submissions).

Variances

Variance requests are typically proposed by building designers. Due to the variability of submitted projects, some may require full or provisional variances. These variances should be requested during schematic design. Allowable justification for variances are limited to:

1. Programmatic conflicts. If the project‘s building program and the B3 Guidelines are in direct conflict with each other, the building program should be respected. If the building program cannot accommodate the guideline, a variance for a specific guideline should be requested (e.g., as the Department of Correction’s program requires a higher light level at the edge of their properties than is specified by B3 Guidelines. A variance to Guideline S.5: Light Pollution Reduction, S5A. Light trespass is regularly approved for Department of Corrections projects.)
2. Project type. Projects with limited scope may wish to request variances for specific guidelines outside the scope of their work.

The B3 Guidelines Team will review variance requests to ensure an appropriate justification for the variance has been identified, and adequate information has been provided. Approval authority for variances lies with the appropriated agency; for the B3 Guidelines, this person is the agency contact. The person charged with reviewing requests should be familiar with the intent of B3 Guidelines. If the agency contact does not feel comfortable with their understanding of the

intent of the guideline, the variance can be referred to the B3 Guidelines Team. Ultimately, variances can be granted, rejected, or amended. Through the variance process, guideline requirements can be provisionally or fully waived. A provisional variance may be considered first, and is requested when there is not enough information available at the current phase to determine if the guideline can be met successfully. A provisional variance is not available during the last required phase of a guideline.

Conditions Not Considered Grounds for a Variance

- Variances will not be considered if alternative design strategies have not been evaluated, including consideration of a creative solution that may maintain the intent of the B3 Guidelines.
- Variances will not be considered on the basis of monetary or convenience rationale.
- Variances will not be considered because compliance with the B3 Guidelines would alter the standard operating procedures of the design team.
- Variances will not be considered on the basis of a site's small or irregular shape or features.
- Note that the variance process is not required for recommended guidelines.
- No variances are available for the requirement to follow the SB 2030 program.

Required Elements of a Variance

A work team proposing a variance should:

- Explain the programmatic conflict necessitating modifications for the particular project.
- Identify a modified performance level and/or compliance method that comes as close to meeting the guideline as possible which will be pursued by the design team.

For example, if a thorough search and proactive conversation with local waste management services in rural Minnesota yield no service options for the required 75% construction waste recycling rate, the work team should identify the maximum waste recycling rate that is available in the region and support that modified performance threshold in the variance request.

Variance Review Process

The Variance Review Process defines the steps for reviewing a request to waive a portion of the guideline as written. This process is intended to be used sparingly, for issues such as non-applicability to a building type, location, or scale. The Variance Review Process is led by the appropriated agency and consists of the following key steps:

- The appropriated agency receives the variance request from the work team and guideline leader.
- After review, the appropriated agency either accepts or rejects the request for variance, or may specify a compromise equivalency or conditions for the variance.
- The appropriated agency documents variance approval or rejection using the B3 Guidelines Tracking Tool.

Compliance Review Process

The Compliance Review Process is designed to provide regular checkpoints for reviewing compliance with the guidelines from the project's initial phases through ongoing occupancy. The appropriated agency leads the Compliance Review Process, which consists of the following key components:

- The appropriated agency receives the Phase Summary Report from the guideline leader, submitted electronically using the B3 Guidelines Tracking Tool.
- The appropriated agency reviews the extent and nature of compliance as documented by the guideline leader and decides if the extent of compliance is acceptable. (The appropriated agency is not responsible for determining compliance, but may question if compliance is achieved.)
- The appropriated agency then either approves the extent of compliance for that phase, or directs the guideline leader to revisit compliance measures with the work team.
- After successful completion of the project, data from each year of occupancy will be reported through the B3 Guidelines Tracking Tool for the life of the building.

B3 Guidelines Tracking Process

The B3 Guidelines Tracking Process consists primarily of updating and maintaining the project information. Related activities may include posting data from the project on the B3 Case Studies Database, using project information to improve the usability and effectiveness of the B3 Guidelines, and translating reported building performance into economic, human, and environmental outcomes for use by the State of Minnesota. This process consists of the following elements:

- Agency completes required approval process for each phase using the B3 Guidelines Tracking Tool. Depending on the phase, outcome documentation may also call for attachment of commissioning or other reports. These attachments will be included in the online submission.
- CSBR receives compliance and outcome information from the agency, via the Tracking Tool.
- CSBR uses the information received to update and maintain project information.
- CSBR provides preliminary review of variances to ensure appropriate justification and information.
- CSBR uses project information at the direction of the State of Minnesota.

The Variance Approval Process

Due to the variability of submitted projects, provisional or full variances may occasionally be necessary for specific B3 Guidelines. A description of these two types of variances follows:

Provisional Variance: A provisional variance is requested when there is not enough information available at the current phase to determine if the B3 Guideline can be met successfully. A provisional variance is not available during the last required phase of a guideline.

Full Variance: Full variances are intended for cases where guidelines are not applicable based on the nature and/or scope of the project. For instance, a prison may not be able to meet Guideline S.5A: Light Trespass, because of higher lighting levels demanded by security guidelines. Full variances must be identified and requested during the schematic design phase of the project, in the Design submission in the Tracking Tool.

In previous versions of the B3 Guidelines, variances were requested by the design team and approved or rejected by the agency contact using the Tracking Tool. This variance process has been used with varying degrees of rigor by agency contacts and necessitates validation. This will be done by a preliminary review of variances by the B3 Guidelines Team. The preliminary review will ensure that variances are pursued for appropriate reasons and that adequate data is provided in variance requests.

References to Other Guidelines and Rating Systems

Whenever possible the B3 Guidelines has been brought into alignment with other guidelines and rating systems. This includes some incorporation of guidelines thresholds from LEED v.4, the International Green Construction Code (IGCC), the WELL Building Standard and Fitwel. There are several benefits to the alignment:

- It leverages others' work in guideline development.
- It provides projects seeking dual compliance a more straightforward documentation path.
- For those project teams that are familiar with other guideline submission requirements, compliance with the B3 Guidelines is more easily verified.

Compliance with a relevant portions of other guidelines or rating systems does not impart compliance with any portion of the B3 Guidelines. Portions of the B3 Guidelines that are similar thresholds as other guidelines and green building rating system have been noted in the footnotes.

Performance Management Guidelines

Intent

The following performance management guidelines assist project teams in gathering necessary information and coordinating the design, construction, and operations processes in order to ensure that each project successfully meets key performance criteria, including those of the B3 Guidelines. Successful implementation of appropriate processes, including integrative design, can minimize risk and improve outcomes.

General Performance Management and Project Information:

The following information is collected in the Performance Management section of the B3 Guidelines Tracking Tool, under Section P.0:

Predesign:

- Project schedule
- Project budget
- Anticipated building information – building gross square footage

Design:

- Updated project schedule
- Updated project budget
- Building information – occupancy, building gross square footage, number of stories

Final Design:

- Updated project schedule
- Updated project budget
- Updated building information – occupancy, building gross square footage, number of stories
- Performance strategies used, including narrative

Closeout:

- Updated project schedule
- Actual project cost
- Updated building information – occupancy, building gross square footage, number of stories
- Updated performance strategies used, including narrative

Occupancy – Submitted annually for ten years:

- Updated building information – occupancy, building gross square footage, number of stories

Guideline P.1: Design and Construction Process

Intent

To support the compliance and outcome tracking process by facilitating the creation and communication of relevant project goals and information.

Required Performance Criteria

A. Develop an Owner's Project Requirements (OPR) document, beginning at the predesign or equivalent phase. This document is developed in coordination between the owner, commissioning authority, architect, engineer and any other relevant stakeholders. A commissioning authority must be established at the predesign phase to complete the early-phase goal setting. The OPR includes:
   1. A list of the authors who developed the document and assisted in early team kickoff and goal setting meeting(s).
   2. All sections listed in Section 6, Appendix D of ASHRAE 202-2013.
   3. A preliminary SB 2030 Energy Standard, as created through the SB 2030 Energy Standard Tool.
   4. Regular updates and developments as the owner's requirements change and project details become available.
   5. The requirement that trend data is able to be saved for major equipment for a minimum of two months if a building automation system is requested in the OPR.

B. Develop a Commissioning Plan (Cx Plan) from the OPR with the assistance of the architect, engineer, commissioning authority and owner. The Cx Plan should follow section 7 and Appendix E in ASHRAE 202-2013. The scope of commissioning shall:
   1. Include mechanical HVAC systems including testing, adjusting and balance; energy, (including renewable) systems; power and electrical systems, including lighting and daylighting controls; indoor air quality elements and systems.
   2. Follow the process outlined in Appendix P-1b1 and P-1b2.

C. Develop a Basis of Design document (BoD) from the OPR with the assistance of the architect, engineer, commissioning authority, and owner. The BoD should follow section 8 and Appendix F of ASHRAE 202-2013.

D. Develop a safety risk assessment of indoor air quality issues for projects that are attached to occupied buildings ("new building" additions or "major renovations" only).

E. Develop indoor air quality procedures according to a Construction Air Quality Management Plan and Warranty Period Air Quality Management Plan. The Construction Air Quality Management Plan and the Warranty Period Air Quality Management Plan must have at a minimum the sections outlined in Templates P1E-1 and P1E-2.

Recommended Performance Criteria

F. Assemble an appropriate stakeholder team that includes representation from every discipline involved in the project, including: the owner's decision-making team, users, occupants, operations and maintenance representatives, at least one representative from the community, and at least one agency "client" or visitor representative. An owner representative and commissioning agent must also be included, if applicable. Members must make a commitment through post-occupancy.

G. Facilitate planning/review workshops at key phases with all team members.
   1. In Predesign:
      i. Comprehensive planning workshop
      ii. Programming workshop
   2. In Design:
      i. Conduct facility performance workshop within the first 2–3 weeks of the design phase.
      ii. Convene a multidisciplinary team at least once per design phase for integrated progress review toward guidelines.
      iii. Convene a stakeholder team for regularly integrated progress reviews. Stakeholder team to meet a minimum of once per phase.
      iv. Convene general contractor and subcontractors for preconstruction kickoff meeting to review the B3 Guidelines goals and objectives.
      v. Discuss progress toward project outcomes during construction meetings.
   3. After occupancy:
      i. Convene facility operations manager, human resources manager, and others who offer cross-disciplinary points of view on facility operations for annual meetings to review operation practices, complaints, and building maintenance issues.

H. Additional Commissioning Scope. Incorporate into the commissioning of the project one or more of the following:
   1. Plumbing Systems
   2. Interior materials
   3. Physical measurement of vibrations/acoustics/noise

Meeting the Guidelines

Note that Guideline P.1 includes several sub-guidelines: P.1A, P.1B, and P.1C, which are typically performed by a commissioning agent. The remainder of the guidelines under P.1 are not typically within the scope of the commissioning agent and are instead usually assigned to the contractor because they relate to planning specific construction and warranty period air quality. Sub-guideline P.2A may fall under the scope of the commissioning agent, design mechanical engineer, or other team members, according to the owner’s needs. Sub-guideline P.2A involves capturing specific operation parameters essential to optimal building operation. Support for this process may be available from the SB 2030 Operations Team.

To meet the guidelines, an owner must engage a commissioning agent as early as a potential project is identified during the predesign of the project to assist the owner in developing the Owner’s Project Requirement (OPR) document. The creation of this document outlines the goals and requirements of the owner. It is useful to have the assistance of the commissioning agent in its creation, as they will be verifying the design and construction against these requirements. The OPR document lays out several key requirements of a building’s design and operation.

The OPR also creates a set of fundamental requirements that the commissioning agent can check the completed project against, rather than relying on the plans and specifications for validating the success of the design and construction process.

The Basis of Design document (BoD) is developed after the OPR and consists of information related to the specific design of the project in order to create a common understanding of how the OPR is being achieved by the design of the project. This document may also serve as a reference for owner input and approval of design decisions as needed.

The Commissioning Plan (Cx Plan) document provides an outline and documentation of measuring how the design, construction, and operation of the building meet the OPR.

Each of these documents should be edited and developed as the design and the project requirements evolve.

Submittal Requirements

Predesign:

- P.1A: Owners Project Requirements (OPR).
- P.1B: Commissioning scope and commissioning budget.
- P.1D: Safety risk assessment if work is to be done to an existing building (either a renovation or addition).
- P.1G: Meeting minutes of goal setting workshops.

Design:

- P.1A: Updated OPR.
- P.1B: Draft Cx Plan.
- P.1C: Draft Basis of Design (BoD).
- P.1D: Updated Safety Risk Assessment.
- P.1F: Members of stakeholder team.

Final Design:

- P.1A: Final OPR.
- P.1B: Final Cx Plan.
- P.1C: Updated BoD.
- P.1D: Final Safety Risk Assessment.
- P.1E: Specifications Requiring Construction Air Quality Management Plan.
- P.1F: Updated members of stakeholder team.
- P.1G: Dates and attendees of design planning and review workshops

Closeout:

- P.1B: Commissioning report, including system manual and training plan.
- P.1E: Construction Air Quality Management Plan.
- P.1E: Warranty Period Air Quality Management Plan.
- P.1F: Updated members of stakeholder team.
- P.1G: Updated meeting minutes of planning and review workshops.

Occupancy:

- P.1B: Cx Report (only for year 1 if not captured at closeout).
- P.1G: Meeting minutes of occupancy workshops (only for year 1)

Additional Resources

Appendix P-1a

Appendix P-1b

ASHRAE Standard 202-2013: http://www.techstreet.com/standards/ashrae-202-2013?product_id=1862482

Federal Energy Management Program Building Program: energy.gov/eere/femp/federal-energy-management-program

LBNL Study *Building Commissioning: A Golden Opportunity for Reducing Energy Cost and Greenhouse Gas Emissions*: http://cx.lbl.gov/documents/2009-assessment/lbnl-cx-cost-benefit.pdf

Guideline P.2: Operations Process

Intent

To ensure that buildings perform optimally.

Required Performance Criteria

A. Develop and implement an SB 2030 Energy Efficient Operations Manual (EEOM). The EEOM defines tasks to ensure that each significant energy consuming device uses only as much energy as needed to serve its intended function. An EEOM is required for all projects meeting the following criteria, subject to the listed exclusions.
   1. Applicable buildings meet any of the following criteria:
      i. Over 100,000 gross square feet (gsf) in size.
      ii. Between 50,000 and 100,000 gsf with an EUI above 100 kBtu/sf.
      iii. Fails to meet SB 2030 target during their second year of operation.
   2. Exclusions:
      i. Buildings in which the EEOM program does not support the HVAC system types.
      ii. Buildings under 50,000 gsf that meet their SB 2030 target in their second and subsequent years of operation.
      iii. Buildings under 20,000 gsf.
      iv. Buildings operated by agencies or organizations with substantially similar or more robust energy management procedures to the EEOM. These plans and procedures must be reviewed and approved by the B3 Guidelines Operations Team. These procedures are not required to be building specific.

B. Facilitate the completion of at least one post-occupancy evaluation (POE) of the project after the first 12 months of occupancy.
   1. The Scan-Level Post-Occupancy Evaluation is required for available space types present in the project. This process is supported by the B3 Post-Occupancy Evaluation (B3 POE) process.
   2. Buildings without supported space types at six months post-occupancy are exempt from this requirement. Projects may also be exempt if they do not meet the minimum required number of occupants or residents; more details are available at the B3 POE website.

Recommended Performance Criteria

C. Reserve 0.25% of total construction cost for contingency in order to meet the SB 2030 Energy Standard in Operations. As compliance with the SB 2030 program is required through ten years of operation, 0.25% of total construction cost is required to be set aside for efforts related to evaluating and remediating non-compliance in SB 2030 projects. This budget includes professional services over and above the services originally contacted for and additional construction costs that may be incurred to meet the SB 2030 Energy Standard if the project fails to meet the SB 2030 standard after the first year.

Meeting the Guidelines

P.2A:

For more information on completing and using the EEOM please visit: http://www.b3mn.org/operations/. The B3 Operations Team may be able to facilitate the creation of the EEOM for projects subject to the requirement. This facilitation and support will require availability and coordination of design and operation team members. To ensure the

maximum available level of support is available to a project, please contact operations@b3mn.org no later than 60 days prior to the completion of construction.

P.2B:

There are three (3) levels of sustainable POE surveys (SPOES): Scan, Core, and Advanced. The required Scan survey is available for select building types and is free for state-funded projects adhering to B3 Guidelines. Complete details can be found at www.b3mn.org/poe/. Buildings with space types with no supported SPOES at 6 months post-occupancy are exempt from this requirement. Projects may also be exempt if they do not meet the minimum required number of occupants or residents. A contact will need to be established who will serve as the primary contact for the survey collection process will need to be established.

The goal of these evaluations is to standardize the methodology for studying a building's performance from the occupant's point-of-view, to provide feedback to the owners and operators, and to understand how the building performs in practice.

Submittal Requirements

Predesign:

- P.2C: Budget showing compliance with contingency.

Design:

- P.2C: Budget showing compliance with contingency.

Final Design:

- P.2C: Budget showing compliance with contingency.

Closeout:

- P.2A: Draft SB 2030 Energy Efficient Operations Manual (created online)
- P.2C: Budget showing compliance with contingency.

Occupancy – Submitted Annually for ten years:

- P.2A: Use of SB 2030 Energy Efficient Operations Manual (managed online)
- P.2B: (One time during occupancy) Sustainable Post-Occupancy Evaluation report.

Additional Resources

ASHRAE Standard 100-2015: https://www.ashrae.org/resources--publications/bookstore/standard-100

ASHRAE Guideline 4-2008: http://www.techstreet.com/standards/guideline-4-2008-ra-2013-preparation-of-operating-and-maintenance-documentation-for-building-systems?product_id=1852923

B3 POE Site (including library of prior POE results): http://b3mn.org/poe/index.html

SB 2030 Energy Efficient Operations: http://b3mn.org/operations/

Energy & Atmosphere Guidelines

Intent

Goal

To promote energy efficient buildings and renovations that reduce the state's expenditures on imported fuel and power and have the lowest reasonable environmental impacts resulting from energy generation and the use of refrigerants harmful to the atmosphere. A parallel goal is to support and enhance the state's building benchmarking activities for ongoing operations performance.

Overview

Energy consumption for building operations represents approximately one third of the total energy use in the State of Minnesota. This section of the B3 Guidelines provides guidance on mitigating both the cost of energy and associated ecological impacts that affect the state's economy. For each building, there are multiple paths to conservation. To further reduce impacts on the environment and to promote community economic development, this guide requires a minimal baseline of onsite wind or solar renewable energy and recommends the investigation of renewable and distributed forms of power generation using wind, solar, and biomass technologies as well as other cleaner forms of hydrogen or hydrocarbon-based power generators. Combined Heat and Power (CHP) systems may be an appropriate solution for individual buildings or groups of state facilities.

Objectives

- Design New Buildings and Major Renovations subject to SB 2030 to meet the energy benchmarks of the SB 2030 program.
- Provide building performance data for benchmarking activities.
- Reduce plug loads and process energy through energy-smart purchasing practices.
- Design New Buildings and Major Renovations to source at least 2% of their SB 2030 target or better final energy use from onsite renewable sources.
- Encourage the consideration of additional power usage from renewable energy and cleaner generation systems whether generated onsite or purchased from offsite “green power” generated in Minnesota.
- Encourage the installation of onsite renewable energy systems to provide 2% of total building energy use, in accordance with Minnesota legislation.
- Encourage the balanced consideration of global warming potential, ozone depletion potential, and atmospheric lifetime in selecting refrigerants.
- Help assure that long-term operations meet or exceed original design operating parameters.

General Energy and Atmosphere Information:

The following information is collected in the Energy and Atmosphere Section of the B3 Guidelines Tracking Tool, under Section E.0:

Final Design:

- Energy and atmosphere strategies used, including narrative.

Closeout:

- Updated energy and atmosphere strategies used, including narrative.

Guideline E.1: Energy Efficiency

Intent

To meet energy-efficiency performance standards for buildings to significantly reduce carbon dioxide emissions by lowering energy use.

Required Performance Criteria

A. Meet MN SB 2030 Energy Standards, information on which can be found at www.b3mn.org/2030energystandard. Results and compliance are tracked in the B3 Guidelines Tracking Tool.
B. Document predicted and actual energy use by type. For all New Buildings and Major Renovations, document predicted and actual energy use by type in the B3 Guidelines Tracking Tool, including recording modeled plug loads and sub-metered actual plug loads separately from other electrical loads in the built project.

Meeting the Guidelines

Please refer to the SB 2030 project website, at http://www.b3mn.org/2030energystandard for more guidance on SB 2030 compliance, including submittal requirements.

Guideline E.2: Renewable Energy

Intent

To require a minimal use of onsite renewable energy and to encourage the broader consideration and use of renewable energy sources and cleaner forms of energy to reduce atmospheric pollution. This can provide a stimulus to the state's economy through investments in local jobs and materials while reducing the state's expenditures on imported fuel and power. The language of this guideline is intended to align with Minnesota legislation, which requires an economic analysis of onsite solar-and-wind-derived renewable energy systems sufficient to offset 2% of predicted energy demand (MN Statute §16B.32, Subd 1a). This legislation requires the installation of such systems unless explicit reasons are provided that rule out installation.

Required Performance Criteria

Guidelines apply to all projects designated New Buildings and are recommended for Major Renovations.

A. Provide at least 2% of energy needs with onsite solar or wind renewable sources:
   Eligible wind and solar renewable sources may include:
   1. Photovoltaic solar panels which convert sunlight directly into electricity.
   2. Wind turbines that capture wind to turn rotors, which turns a generator and creates electricity.
   3. Transpired solar collectors that use sunlight to preheat air for heating purposes.
   4. Solar thermal systems that use the sun to heat water for heating or domestic hot water uses.

   Analyze at least two scenarios that include the environmental and economic impacts of supplying 2% of the building's anticipated total energy use with onsite renewable generation systems. This is coordinated with Minnesota Statute §16B.326, which states:

   > "a new building must consider meeting at least 2% of the energy needs of the building from renewable sources located on the building site. For purposes of this subdivision, 'renewable sources' are limited to wind and the sun. The Predesign must include an explicit cost and price analysis of complying with the 2% requirement compared with the present and future costs of energy supplied by a public utility from a location away from the building site and the present and future costs of controlling carbon emissions. If the analysis concludes that the building should not meet at least 2% of its energy needs from renewable sources located on the building site, the analysis must provide explicit reasons why not."[1]

   Evaluation of the feasibility of the 2% systems for projects shall be done using the B3 Levelized Cost of Energy (LCOE) Calculator to determine if the levelized cost of wind or solar is less than the combined price of grid energy and carbon. The tool includes several generic values for costs at the predesign phase to streamline evaluation which are refined at later phases. Installation of a system meeting 2% of the anticipated energy need of the project is required if the evaluation determines that the levelized cost of energy from a proposed system is less than the combined price of grid energy and carbon.
B. Design project to be solar-ready to facilitate future solar design retrofits or expansion of installed systems.
   Solar-ready considerations include planning for the location of solar systems in building orientation and massing, structure to support solar systems, electrical or plumbing chases, dedicated mechanical space, and planning for maintenance access to allow straightforward installation and operation.

[1] Minnesota Statute §16B.32, Subd. 1a. www.revisor.mn.gov/statutes/?id=16B.32

Recommended Performance Criteria

C. Provide 10% of energy needs with renewable and cleaner distributed generation systems.
Consider the inclusion of all renewable and cleaner distributed generation approaches to meet 10% or more of the buildings energy needs. This goal may be achieved through the construction budget by paying for the design and installation of a renewable or cleaner distributed generation system or through the operating budget through a contract to purchase renewable or cleaner distributed generation.

D. Provide 100% or more of energy needs with renewable and cleaner distributed generation systems.
Consider the inclusion of all renewable and cleaner distributed generation approaches to meet 100% or more of the buildings energy needs. This goal may be achieved through the construction budget by paying for the design and installation of a renewable or cleaner distributed generation system or through the operating budget through a contract to purchase renewable or cleaner distributed generation.

Meeting the Guidelines

Implementation in the Design Process:

Identify the potential investment value of onsite generation to offset 2% of predicted energy use during Predesign and site selection. Evaluate and adjust building geometry and orientation for solar-based energy solutions, and investigate the viability and potential of other onsite renewable and distributed energy options. Also evaluate the proximity to nearby renewable distributed energy generation sources and the transmission potential to the site and/or the investment potential for the project.

Two options must be investigated using the LCOE calculator to achieve compliance with E.2 Renewable Energy: a solar photovoltaic (PV) option, and either a solar hot water or small wind option. Transpired solar thermal collectors may be evaluated as an second option but are not supported by the LCOE calculator. If the design team wishes to pursue this option the B3 Guidelines Team may be consulted to assist in calculating levelized cost. Each of these three technologies has its own tab in the LCOE tool. Note that ground source (geothermal) heat pumps, air source heat pumps, and passive solar energy may be desirable for the project, but do not qualify to meet the requirements of E.2.

During the Predesign phase the LCOE calculator requires a small number of inputs to perform the levelized cost of energy calculation. These inputs typically include the required yearly energy production (>/= 2% of predicted total building energy use as determined by the SB 2030 Energy Standard Tool (E.1.c)) and the yearly average fuel/electricity costs at the site (including any demand charges, delivery charges, surcharges, and fees). All other necessary inputs are generally either provided as defaults or assumptions built into the calculation cells. Input cells with default values should not be adjusted unless there is reason to adjust them. Calculation cells are locked so users cannot adjust them.

During the Design phase, locate renewable and distributed energy installation areas on plans, elevations and sections as appropriate. Investigate spatial and loading impact on site, architectural, mechanical and electrical systems and develop preliminary performance specifications for the selected technology(s). The Design and Final Design versions of the LCOE calculator require more detailed information than the predesign version, and should correspond to contractor refined performance characteristics, energy production, and cost. Outputs of the refined assumptions are uploaded in the B3 Guidelines Tracking Tool at the Design phase and updated with final estimates for Final Design phase. Identification of which system was installed will be verified at project Closeout.

Related Legislation:

There may be implications resulting from Minnesota Statute §16B.323, which states in part that the project may, “after the completion of a cost-benefit analysis, may include installation of “Made in Minnesota” solar energy systems of 40

kilowatts capacity on, adjacent, or in proximity to the state-funded building." Additionally "The capacity of a solar system must be less than 40 kilowatts to the extent necessary to match the electrical load of the building or to the extent necessary to keep the costs for the installation below the five percent maximum…" Note that this limits the cost of "Made in Minnesota" solar that can be installed on site to no more than 5 percent of the appropriation.

Minnesota Statute §16B.326 states that "when practicable, geothermal and solar thermal heating and cooling systems must be considered when designing, planning, or letting bids for necessary replacement or initial installation of cooling or heating systems in new or existing buildings that are constructed or maintained with state funds. The Predesign review must include a written plan for compliance with this section from a project proposer. For the purposes of this section, "solar thermal" means a flat plate or evacuated tube with a fixed orientation that collects the sun's radiant energy and transfers it to a storage medium for distribution as energy for heating and cooling."

This section does not provide a comprehensive list of potentially relevant legislation or the full text of those statues cited. Please reference the Revisor of Statues of the State of Minnesota for full legislation text.

Submittal Requirements

Predesign:

- E.2A: Predesign plan for projects using state predesign process, Predesign LCOE calculator documenting two systems evaluated (including at least one PV) for meeting 2% of annual energy demand.

Design:

- E.2A: Design LCOE calculator documenting two systems evaluated for meeting 2% of annual energy demand including contractor estimates of performance, energy production and cost.
- E.2B: Verification of solar-ready design features included in project.
- E.2C: Detail and verification of system meeting 10% of annual energy need.
- E.2D: Detail and verification of system meeting 100% of annual energy need.

Final Design:

- E.2A: Updated LCOE calculator documenting two systems evaluated for meeting 2% of annual energy demand, including updated contractor estimates of performance, energy production and cost, and selection of which system planned for installation.
- E.2B: Verification of solar-ready design features included in project.
- E.2C: Detail and verification of system meeting 10% of annual energy need.
- E.2D: Detail and verification of system meeting 100% of annual energy need.

Closeout:

- E.2A: Updated LCOE calculator documenting two systems evaluated for meeting 2% of annual energy demand, including updated contractor estimates of performance, energy production and cost, and selection of which system installed.
- E.2B: Verification of installed solar-ready design features included in project.
- E.2C: Detail and verification of system installed meeting 10% of annual energy need.
- E.2D: Detail and verification of system installed meeting 100% of annual energy need.

Additional Resources

Minnesota renewable legislation: MN Statute §16B.32, Subd 1a: www.revisor.mn.gov/statutes/?id=16B.32

Minnesota Legislation: Solar Energy in State Buildings: §16B.323 Solar Energy In State Buildings: www.revisor.mn.gov/statutes/?id=16B.323

Minnesota Legislation: Geothermal Energy in State Buildings: §16B.326 Heating And Cooling Systems; State-Funded Buildings: www.revisor.mn.gov/statutes/?id=16B.326

The Database of State Incentives for Renewable Energy (DSIRE):. http://www.dsireusa.org/

RETScreen software: www.retscreen.net

The Minnesota Department of Commerce guidance documents and model solar-ready specifications: http://mn.gov/commerce-stat/pdfs/solar-ready-building.pdf

Guideline E.3: Efficient Equipment and Appliances

Intent

To reduce energy use associated with plug loads and process loads in buildings. These strategies may also contribute to meeting the SB 2030 Energy Standard if using a performance approach (documenting design energy use with a simulation).

Required Performance Criteria

A. Select new equipment and appliances that meet Energy Star criteria.

Meeting the Guidelines

Implementation in the Design Process:

Budget for energy efficient (Energy Star) equipment and appliances in early planning phases.

During construction documents, provide drawings, cut sheets, and specifications highlighting compliance of equipment and appliances with Energy Star requirements. Document efficiency ratings of motors and drives, water service equipment, and other electrical load components. During construction administration, review shop drawings to assure compliance with energy efficient equipment specifications.

Submittal Requirements

Final Design:

- E.3A: Verification of specification of Energy Star appliances for available appliance types.

Closeout:

- E.3A: Verification of selection of Energy Star appliances for available appliance types.

Additional Resources

DOE ENERGY STAR Program: www.energystar.gov

Guideline E.4: Atmospheric Protection

Intent

To encourage the investigation and evaluation of refrigerants to reduce environmental impacts harmful to the atmosphere. Energy conservation should be achieved with the lowest reasonable environmental impacts.

Recommended Performance Criteria

Guidelines apply to all projects designated New Buildings and are recommended for Major Renovations.

There are no required levels for atmospheric pollution from refrigerants at this time except for CFC reduction, which is required in the MN State Building Code. Meet the following criteria refrigerants:

A. Achieve an Atmospheric Lifetime (AtL) < 33. Atmospheric Lifetime is a measure of the average persistence of the refrigerant if released. A longer lifetime has worse environmental effects.
B. Achieve an Ozone Depletion Potential (ODP) < 0.034. Ozone Depletion Potential is a normalized indicator based on the ability of a refrigerant to destroy atmospheric ozone, where CFC-11 = 1.00. A higher ODP has worse environmental effects.
C. Achieve a Global Warming Potential (GWP) < 3500. Global Warming Potential is an indicator of the potency of the refrigerant to warm the planet by action as a greenhouse gas. A higher GWP has worse environmental effects.
D. Design, maintain, and operate the mechanical equipment to reduce refrigerant leakage over the life of the building.

Meeting the Guidelines

Refrigerant Climate Data[2]

Refrigerant	Atmospheric Lifetime in Years	Ozone Depletion Potential	Global Warming Potential
HFC-152a	1.4	0	120
HCFC-123	1.4	0.012	120
HCFC-21	2	0.01	210
HFC-32	5	0	550
HCFC-124	6.1	0.026	620
HFC-245fa	7.2	0	950
HFC-134a	13.8	0	1300
HCFC-22	11.9	0.034	1700
HFC-125	29	0	3400
HFC-227ea	33	0	3500

CFCs generally have high Ozone Depletion Potential and Global Warming Potential with long Atmospheric Lifetimes. CFCs are therefore not allowed by these guidelines and prohibited by MN state law. Halons have a higher Ozone Depletion Potential though a lower Global Warming Potential but a much longer Atmospheric Lifetime. Halons should be avoided if possible. HCFCs such as R-123, which other guides put in the same class as Halons, can have an Ozone

[2] James M. Calm, "Refrigerant Data Summary," *Engineered Systems Magazine* November 2001.

Depletion Potential, a Global Warming Potential and an Atmospheric Lifetime two orders of magnitude less than CFCs and Halons. HFCs offer near zero Ozone Depletion Potential, but some have high Global Warming Potential. For example, R-134 has an Ozone Depletion Potential of 0.0 but a Global Warming Potential and an Atmospheric Lifetime approximately ten times greater than R-123, an HCFC alternative. Substituting an HFC, which tends to be less energy efficient than an HCFC, may result in the use of more energy, resulting in a further increase in global warming.

Implementation in the Design Process:

In Predesign and early design determine onsite fire suppression requirements. Plan and organize building to minimize the need for the use of Halon fire suppression systems

Using the tables above and other information as may be available at the time of design, identify candidate refrigerants that have a low Global Warming Potential, short Atmospheric Lifetime, and a low Ozone Depletion Potential.

Use one of the weighted evaluation metrics provided to evaluate the refrigerants, and prioritize the list in the order given. Evaluate the economic and community impacts of the prioritized list and adjust priorities pursuant to the analysis.

In construction documents based on this analysis, develop specifications based on adjusted priorities. Verify shop drawings to assure compliance.

Submittal Requirements

Final Design:

- E.4A: Verification of atmospheric lifetime limits met for refrigerants.
- E.4B: Verification of ozone depletion limits met for refrigerants.
- E.4C: Verification of global warming potential limits met for refrigerants.
- E.4D: Verification of design intended to reduce refrigerant leakage.

Closeout:

- E.4A: Verification of atmospheric lifetime limits met for refrigerants.
- E.4B: Verification of ozone depletion limits met for refrigerants.
- E.4C: Verification of global warming potential limits met for refrigerants.
- E.4D: Verification of design intended to reduce refrigerant leakage.

Additional Resources

EPA Significant New Alternatives Policy, Reducing Hydrofluorocarbon Use and Emissions in the Federal Sector: https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector

Indoor Environmental Quality Guidelines

Intent

To provide high quality indoor environmental conditions to promote occupant health, well-being, and productivity. This is achieved through both the reduction of the conditions that contribute to negative outcomes, and support for the conditions associated with increased health, comfort, and productivity.

General Indoor Environmental Quality information:

The following information is collected in the Indoor Environmental Quality Section of the B3 Guidelines Tracking Tool, under Section P.0:

Final Design:

- Indoor environmental quality strategies used, including narrative.

Closeout:

- Updated Indoor environmental quality strategies used, including narrative.

Guideline I.1 Low Emitting Materials

Intent

To minimize occupant exposure to volatile organic compounds.

Required Performance Criteria

A. All newly installed interior materials must comply with California Department of Public Health (CDPH) Standard Method v1.1–2010 or v1.2–2017. Interior materials are defined as all materials and finishes interior to the enclosure's least vapor-permeable and continually air-sealed barrier system. This includes but is not limited to flooring adhesives, sealants, carpets, resilient flooring, paints, acoustical insulation products, gypsum board, acoustical ceilings, acoustic wall panels, casework, composite wood subflooring, and furnishings. [3]

1. Exceptions:
    i. Inherently non-emitting sources: Products that are inherently non-emitting sources of volatile organic compounds (VOCs) (stone, ceramic, powder-coated metals, plated or anodized metal, glass, concrete, clay brick, and unfinished or untreated solid wood flooring) are considered fully compliant without any VOC emissions testing if they do not include integral organic-based surface coatings, binders, or sealants.
    ii. Salvaged and reused architectural millwork more than one year old at the time of occupancy is considered compliant, provided it meets the requirements for any site-applied paints, coatings, adhesives, and sealants. Newly installed finishes and components are not exempt from I.2A or I.2B.
    iii. Product types with two or fewer compliant manufacturers available from the combination of all databases listed below at the point of product selection are exempt from this requirement.[4]
    iv. Structural building products as excluded from CDPH Standard Method v1.1 under part 1.1.4.
    v. Composite wood products covered under Guideline I.2C.
    vi. Furnishings covered under Guideline I.2D. Onsite applied furniture coatings are not exempt from the requirements of I.2A.
2. Approved databases of materials recognized as compliant with the most current CDHP standard:
    i. Collaborative for High Performance Schools (CHPS) Low Emitting Materials (which includes several of the other third-party certifications below).
    ii. Carpet and Rug Institute (CRI) Green Label Plus™ Certification (for carpet, cushion, and adhesive products).
    iii. Scientific Certification Systems (SCS) Indoor Advantage Gold™ Certification.
    iv. Resilient Flooring Institute (RFI) FloorScore™ Certification.
    v. Underwriters Laboratory (UL) GREENGUARD Gold™.
    vi. Intertek ETL Environmental™ VOC+.
    vii. Materials Analytical Services, LLC (MAS) Certified Green™ (for Building Materials).
    viii. NSF/ANSI 332 (for Resilient Floor Coverings).
    ix. Berkeley Analytical Associates ClearChem (for Interior Building Products).
    x. Coatings Research Group, Incorporated (CRGI) Green Wise Gold (for Paints).

[3] This guideline is aligned with the USGBC, "Indoor Environmental Quality Credit: Low-Emitting Materials," *LEED Building Design and Construction v.4*, though with a different definition of interior materials and a different threshold for compliance.
[4] Allowable exclusions differs from LEED v.4.

B. Wet-applied materials: All onsite wet-applied materials must meet the applicable requirements below. Interior onsite wet-applied materials also must meet the general requirements for VOC emissions under I2A.
   1. All paints and coatings wet-applied onsite must meet the applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for Architectural Coatings, or the South Coast Air Quality Management District (SCAQMD) Rule 1113, effective June 3, 2011.
   2. All adhesives and sealants wet-applied onsite must meet the applicable chemical content requirements of SCAQMD Rule 1168, July 1, 2005, Adhesive and Sealant Applications, as analyzed by the methods specified in Rule 1168.
   3. Paints, coatings, adhesives and sealants wet-applied onsite may not include any intentionally added methylene chloride or perchloroethylene.

C. Composite Wood Products: Newly installed composite wood must meet the California Air Resources Board ATCM for formaldehyde requirements for ultra-low-emitting formaldehyde (ULEF) resins or no added formaldehyde resins.

D. New furniture and furnishing items not tested under I.2A must be tested in accordance with ANSI/BIFMA Standard Method M7.1–2014. Comply with ANSI/BIFMA e3-2014 Furniture Sustainability Standard, Section 7.6.1 or 7.6.2.
   1. Furniture listed in the following databases or providing the following certifications are considered compliant with this guideline:[5]
      i. Scientific Certification Systems (SCS) Indoor Advantage (furniture)
      ii. Scientific Certification Systems (SCS) Indoor Advantage Gold (furniture)
      iii. Underwriter Laboratories (UL) Greenguard Certified
      iv. Underwriter Laboratories (UL) Greenguard Gold Certified
      v. Intertek ETL Environmental VOC (furniture)
      vi. Intertek ETL Environmental VOC+ (furniture)
      vii. Materials Analytical Services, LLC (MAS) Certified Green

Recommended Performance Criteria

E. After construction and before occupancy, conduct air-testing to ensure that the contaminant levels listed in the USGBC document “Maximum Concentration Levels, by Contaminant and Testing Method” are not exceeded using the test methods listed in that document. If excessive levels of contaminants are found in the building, develop a mitigation plan to reduce these and retest until acceptable thresholds are reached. Conduct testing in spaces representing typical airflow conditions and interior finishes.

Meeting the Guidelines

During Predesign and early design, identify all applicable product types to be used in the project. All interior materials on interior assemblies must be included (though some materials in these may be subject to the listed exclusions). For exterior assemblies this is done by determining which continuously sealed material or set of materials is least vapor-permeable and including all materials interior of that boundary. Note that there may be materials (such as metal cladding) that are the least vapor-permeable layer but which are not continually sealed, and should not be considered as the boundary of interior materials.

The recommended method for tracking this guideline is for an assigned team member or members to keep a running list of products and their VOC content compliance information, complete with manufacturer's documentation. If a product category has been identified but a complaint product has not yet been selected, products may be found in the list of

[5] Allowed furnishings differ from LEED v.4.

approved databases in the guideline requirements. Communication with manufacturers and product representatives may aid in the discovery of compliant products.

Through the design process, compile required documentation and maintain and update the list of materials. Review project documents to identify all applicable products and specify them as low- or non-emitting. Track and report all interior materials in the B3 Guidelines Tracking Tool, even those that are excluded from VOC content requirements.

For bid and construction documents preparation, verify continued selection of compliant interior materials and products to reflect guideline requirements. Provide contractor with detailed specifications to ensure that the team has the information needed to meet the B3 Guideline requirements. The design team should specifically call out compliant products and only specify allowable substitutions that also meet the guideline requirements.

Input compliant products into the B3 Tracking Tool by uploading a list of all interior materials used in the product and their method of achieving compliance or qualifying for an exemption. Note that compliance with I.2B may be documented through a Certificate of CARB Compliance from the Hardwood Plywood and Veneer Association or the Composite Panel Association. The absence of added methylene chloride and perchloroethylene may be determined from the MSDS for a material.

Coordinate reviews of the construction submittals to ensure that selected products meet the guideline requirements and do not exceed the allocated VOC emissions limits. All review submittals, substitution requests and changes to the construction contract should be carefully reviewed by the design team and contractor for compliance with guideline requirements.

Because meeting these guideline requirements is not typical for all construction teams and suppliers, conducting a B3 Guideline-specific preconstruction meeting to review the requirements in detail and stress their importance will aid in successful product procurement.

A Note for Suppliers, Contractors, and Subcontractors:

During construction, interior paints and coatings applied onsite represent the largest source of VOC emissions. Awareness of VOC levels in paints and coatings is a key step in ensuring the building project is sustainable, and selecting an approved paint, primer or stain is as easy as finding a compliant certification mark as listed in the guideline text. Similarly, awareness of interior adhesives and sealants applied onsite (including flooring adhesives) is also a key factor in compliance.

Carpet installation requires that the carpet, carpet cushion, and carpet adhesive all be compliant with this guideline. Installation of other floorings such as tile, masonry, cut stone, concrete, and wood require that any the flooring product and any finishes or sealers meet the same requirements as paints.

During closeout, monitor submittals and construction site to ensure that materials, products, and systems are being correctly installed to preserve project goals and objectives. Review substitutions based on performance criteria to ensure consistency and compliance with goals as represented in the drawings and specifications.

Document changes to requirements for construction that occur that may impact the provision or installation of materials, products, or components that were intended to ensure indoor air quality standards are achieved.

It is also recommended to use low- or noVOC emitting materials for products including cleaning supplies, pest management applications, minor remodeling, and maintenance associated with “churn” or standard product replacement of furnishings and finishes and to see the full benefit of lowered VOC emissions.

Retain final product compliance documentation as part of the B3 records.

Submittal Requirements

Design:

- I.1A: List the material categories needed to meet the guideline.

Final Design:

- I.1A: List all interior materials specified to meet the guideline in the required material categories, including method of compliance, compliant specifications.
- I.1B: List all wet-applied products specified in the project including method of compliance and relevant specifications.
- I.1C: List all composite wood products specified including method of compliance, compliant specifications, and product documentation.
- I.1D: List all furniture specified including method of compliance, compliant specifications, and product documentation.

Closeout:

- I.1A: List all interior materials installed in the required material categories, including method of compliance.
- I.1B: List all wet-applied products installed in the project including method of compliance.
- I.1C: List all composite wood products installed in the project including method of compliance.
- I.1D: List all furniture installed including method of compliance.
- I.1E: List testing protocols used in the project and results of testing, including levels of listed contaminants and locations tested.

Occupancy – Submitted annually for ten years:

- I.1E: Submit any testing results, whether remediation was necessary and performed remediation methods (if any).

Additional Resources

California Department of Public Health (CDPH), "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Version 1.1, February 2010: http://www.cdph.ca.gov/programs/IAQ/Documents/cdph-iaq_standardmethod_v1_1_2010%20new1110.pdf, Version 1.2, January 2017: https://berkeleyanalytical.com/sites/default/files/CDPH-IAQ_StandardMethod_V1_2_2017.pdf

AQMD Rule 1113: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1113.pdf?sfvrsn=17

OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary: https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary and chRELs as of June 2016: http://oehha.ca.gov/air/allrels.html

Collaborative for High Performance Schools (CHPS) High Performance Products Database: http://www.chps.net/dev/Drupal/node/445

Carpet and Rug Institute (CRI) Green Label Plus Certification for carpet, cushion, and adhesive products: http://www.carpet-rug.org/CRI-Testing-Programs/Green-Label-Plus.aspx

EPA Indoor air PLUS: https://www.epa.gov/indoorairplus

UL SPOT: https://spot.ulprospector.com/en/na/BuiltEnvironment

LEED v.4 EQ Credit Low-Emitting Materials Third Party Certification and Labels: http://www.usgbc.org/resources/low-emitting-materials-third-party-certification-table

Low-Emitting Materials Calculator LEED v.4: http://www.usgbc.org/resources/low-emitting-materials-calculator

South Coast Air Quality Management District Rule 1168 - Adhesive and Sealant Applications: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1168.pdf

Glossary

Interior Materials

Interior materials and finishes are defined as all materials interior to the enclosure's least vapor-permeable and continually air-sealed barrier system. For most enclosure systems this definition will encompass all materials interior and exclusive of the vapor barrier/retarder, though for some assemblies with several systems providing vapor impermeability a further determination will need to be made.

Continually Air-Sealed Barrier System

A continually air-sealed barrier system refers to the set of air-sealed building materials that is intended to prevent air-flow through a wall assembly. This may consist of a continually sealed vapor barrier or a set of materials that when combined provide the least vapor-permeable system. Note that some materials have low vapor permeability but may not be part of a continually sealed system and should not be considered as the boundary of the building's interior.

Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOC) refers to any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, that participates in atmospheric photochemical reactions, except those designated by EPA as having negligible photochemical reactivity. VOCs are organic chemical compounds the composition of which makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure.[6]

Sealants

A sealant has adhesive properties and is formulated primarily to fill, seal, or waterproof gaps or joints between two surfaces. Sealants include sealant primers and caulks.[7] Sealants are used on wood, fabric paper, corrugated paperboard, plastic foam, and other materials with tiny openings, often microscopic, that may absorb or discharge gas or fluid.

Composite Wood Products:

Composite wood products includes hardwood plywood, particleboard, and medium density fiberboard. Composite wood excludes hardboard, structural plywood, structural composite, oriented strand board, glued laminated timber, prefabricated wood I-joists, and finger-jointed lumber.[8]

[6] United States Environmental Protection Agency, "Technical Overview of Volatile Organic Compounds," March 17, 2016.
[7] South Coast Air Quality Management District Rule 1168.
[8] Definition based on California Air Resource Board rules, www.arb.ca.gov.

Guideline I.2 Moisture and Water Control

Intent

Ensure a moisture-safe building envelope.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations with exterior envelope included in the project scope.

A. Bulk water management:

1. Implement the following to ensure adequate control of bulk water on the site:
2. Site grading at building perimeter: Ensure 5% slope away from the building for a minimum of 10 ft. in unpaved and non-pedestrian areas.
3. Use downspout leaders, trench drains, and/or other methods to direct runoff from the building away from the perimeter.
4. Ensure irrigation systems do not spray on the building enclosure.

B. Moisture-safe design:

Design the building envelope to manage moisture flow and maintain all layers of wall and roof assemblies at safe moisture levels by implementing items (1) and (2) below.

1. *For above-grade walls*: Project teams must demonstrate safe moisture design by conducting a qualitative moisture analysis, and by conducting one of two quantitative moisture analysis options. Analysis must be performed for at least two wall assemblies or one wall assembly if it comprises 60% or more of the total wall area. Wall types following the principles of the "Perfect Wall" with all control layers (water, air, vapor, thermal) outboard of the sheathing (i.e. no cavity insulation) do not require the quantitative moisture analysis.

   Qualitative moisture analysis:

   This analysis shall be guided by the B3 Qualitative Moisture Analysis Worksheet for walls, discussing how the assembly manages liquid water, capillary drive, air leakage, and vapor diffusion, including location and type of each control layer: water, air, vapor, and thermal.

   Quantitative moisture analysis:

   Option 1: Static temperature and vapor pressure profile calculation (Glaser method):

   Project teams are encouraged to use the B3 Glaser Calculator Tool. Results must show the interior and exterior surfaces of the wall sheathing remain below the saturation vapor pressure at average winter temperature and humidity conditions (average of the coldest three months).

   Option 2: Dynamic moisture simulation (i.e., WUFI software):

   An analysis following American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 160 must show the wall's total moisture content achieves a declining or stable moisture content pattern over three years while the sheathing meets the mold growth criterion of ASHRAE 160-

2009. This criterion verifies that the highest 30-day running average surface relative humidity in the sheathing is below 80% when surface temperatures are between 41°F and 104°F

2. *For roofs*: Project teams must demonstrate successful moisture performance by conducting a qualitative moisture analysis. Analysis must be performed for at least two roof assemblies, or one roof assembly if it comprises 60% or more of the total roof area.

   Qualitative moisture analysis:

   This analysis shall be guided by the B3 Qualitative Moisture Analysis Worksheet for roofs, and must discuss how the assembly manages liquid water, capillary drive, air leakage, and vapor diffusion, including location and type of each control layer: water, air, vapor, and thermal.

C. Moisture-safe construction:

Air leakage and resulting condensation is one of the primary causes of moisture damage in buildings. Construct the building to control air leakage. Compliance with this guideline can be achieved using one of the two following methods:

1. Whole-building air tightness test:

   Test the building thermal envelope for air tightness using the Air Barrier Association of America (ABAA) Standard Method for Building Enclosure Airtightness Compliance Testing "operational enclosure test." A pressurization test is not required, but may be performed in addition to the required depressurization test. The maximum air leakage rate allowed is 0.25 cubic feet per minute (cfm) per square foot enclosure area (6-sided) at 75 Pascal (Pa).[9] If the rate falls above this level, a diagnostic evaluation to find the primary sources of air leakage is required using smoke tracer or infrared imaging, followed by nondestructive remediation steps to reduce air leakage. A final air tightness test is required following remediation efforts. If the final leakage rate achieved is below 0.4 cfm per sq. ft. at 75 Pa, the building is considered compliant with this guideline.

2. Third-party building enclosure consultant:

   The building enclosure must be designed and constructed with assistance from a third-party building enclosure consultant. This scope of work must include, but is not limited to:

   i. Regularly scheduled meetings and consultations with the design and construction team during each phase (Predesign through construction and project completion).

   ii. Review of all technical plans, specifications, shop drawings, and material submittals relating to the building enclosure.

   iii. Coordination, observation, and documentation of preconstruction training for enclosure contractors and construction managers, focused on proper installation methods for air and water barrier continuity. (The training may be conducted by a qualified third party such as a manufacturer/product representative.)

   iv. Coordination, observation, and documentation of air and water leakage performance testing on window installation mockup and/or field installations. This performance testing may be conducted by a third-party testing agency.

   v. Field observation of critical enclosure details for quality assurance during construction.

[9] This threshold is similar to US Army Corps of Engineers and GSA Requirements

If compliance is achieved through a third-party building enclosure consultant, whole-building airtightness testing is not required as part of the process, though smaller scale assembly or panel testing may be appropriate as determined by the building enclosure consultant. Note that the building enclosure consultant may also perform the work required under Section B, Moisture-Safe Design. Note that a certified building enclosure consultant is preferred, though not required.

Meeting the Guidelines

Moisture control is one of the most important functions provided by a building enclosure. It is vital to building durability and longevity, energy performance, and occupant health. Yet it remains one of the most challenging aspects of building design.

There are four key pathways for moisture to move through a building enclosure. Arranged in order of significance, these are 1) bulk water leakage, 2) capillary movement, 3) air leakage, and 4) diffusion. In general, the building industry has learned to control bulk water leakage using a large variety of materials and products, but relying on a few basic principles such as slope and drainage gaps, redundancy, and proper overlap of layers. Capillary movement can generally be controlled with rainscreens, drainage gaps, and capillary breaks installed in key locations.

Often failure to control bulk water and capillary drive is quickly evident, which is one reason why the building industry has been able to learn adequate methods of control for these wetting pathways. However, diffusion-driven wetting and especially air leakage remain difficult for the building industry to properly control. Modern enclosures incorporate less moisture storage and higher insulation values, which translate into less available heat to drive off excess moisture. Increasingly moisture-sensitive materials may also be selected. As they become less tolerant to moisture, modern enclosures need to be paired with improved methods of air leakage and diffusion control. Better approaches to enclosure design, accessing enclosure expertise, setting air leakage targets, and testing performance have all been shown to improve enclosure durability, energy performance, and moisture safety.

A preferred method to control all four wetting pathways is through the use of an enclosure scheme called the Perfect Wall. This design approach can be safely used in any climate and for any part of the enclosure (wall, roof, slab on grade), as well as above or below grade. It also lends itself to easier installation and quality assurance inspections for the four essential control layers: water control, air control, vapor control, and thermal control. The Perfect Wall approach requires that all of these control layers be positioned outboard of the structure regardless of whether that structure is concrete, wood frame, steel frame, or other. Conveniently, the water, vapor, and air control layers can often be provided with a single product installed on the outside face of the sheathing or outermost structural surface. In this position, it can be installed continuously and inspected more easily than enclosure approaches using multiple layers installed variously inside, outside, and/or within the structure. The thermal control layer is applied outboard of these control layers, protecting them from damage functions and keeping them and the structure warm and dry as well. This outboard system may also be easier to repair or replace during the building's lifespan. More information on the Perfect Wall is listed below under Additional Resources.

This Perfect Wall design approach is known as an inverted or protected membrane roof when applied to the top of the building. The waterproof roofing membrane is placed on top of the roof deck, providing air, vapor, and water control in a single layer. All of the insulation is placed on top of this, typically as rigid foam board, and weighed down and protected with gravel ballast or pavers. Although the roofing membrane is more difficult to inspect and access after construction is complete, it is also longer lasting because it is protected from sun, heat, ice, and physical damage. This type of roof design doesn't create a cold side vapor barrier or double vapor barrier as most other roof designs do, leading to much greater drying potential and moisture safety. It also eliminates common air leakage pathways and

associated moisture issues in truss roofs with dense pack insulation. Building enclosure consultants have found dense-packed truss roofs especially problematic due to the difficulty of creating a continuous, robust air barrier in the ceiling plane.

Adopting the Perfect Wall approach to enclosure design eases the requirements for conducting qualitative and quantitative moisture analysis, as these are considered less likely to have moisture issues. It will also help achieve the demanding air leakage requirement of 0.25 cfm/sq. ft. at 75 Pa, though use of this scheme is just one step toward achieving that target.

Project teams may wish to hire a building enclosure consultant as well, particularly if the project team or contractor has never designed a building that has to achieve this level of airtightness. Building enclosure consultants can help project teams design and construct an air barrier system that maintains continuity even at locations that have traditionally been problematic, such as parapets, windows, and projections like balconies and overhangs. They can suggest products, materials, and approaches that have been proven to perform better in the field or are easier to install in an air- and watertight manner. Building enclosure consultants may also suggest conducting preliminary performance tests around installed components such as windows and doors, or testing the tightness of certain wall sections or building zones. Finding and remediating discontinuities in the air barrier is easier and cheaper early in the construction process (rather than during or after the final blower door test).

Mechanical engineers and contractors also should be aware of the air leakage requirements of these guidelines. Specifying higher quality louvers and dampers that can close fully during normal operation has been shown to significantly improve commercial-scale buildings' air tightness results. A reduced level of air leakage may also impact heating and cooling load calculations and improve mechanical air distribution and pressure management.

WUFI modeling for compliance with the quantitative moisture analysis should be done by experienced professionals. Currently, there are no widely-followed certifications for this particular modeling skill, though many building enclosure consultants and firms do employ people with WUFI modeling experience. It is highly recommended to follow expert guidance for WUFI modeling techniques. Thorough guidance can be found in the Building Technologies Office Strategy Guideline: Modeling Enclosure Design in Above-Grade Walls, 2016.

Submittal Requirements

Predesign:

- I.2C: Determination of which method the project is pursuing. If the project team is using a third-party building enclosure consultant, add the consultant to the B3 Project Team in the B3 Tracking Tool and submit a description of the consultant's contractual scope of work.

Design:

- I.2B: Complete and submit the B3 Qualitative Moisture Analysis Worksheets for the proposed primary roof and exterior above-grade wall assemblies. Submit either 1) completed B3 Glaser Calculator Tool with calculations for the proposed wall assembly, or 2) WUFI simulation results for the proposed wall assembly including documentation of the modeled wall materials and properties, simulation settings, and moisture content or relative humidity graphs at the sheathing surfaces, showing compliance with ASHRAE 160-2009.
- I.2C: If project team has determined to use a third-party building enclosure consultant, submit minutes and/or reports from the Design Development-phase meetings with the enclosure consultant.

Final Design:

- I.2A: Submit site plans documenting proper slope next to the building and location and direction of water flowing through downspout leaders and/or trench drains. Submit an irrigation plan identifying location and coverage of spray irrigation or sprinkler heads.
- I.2B: If changes have been made to the primary roof and exterior above-grade wall assemblies, complete and re-submit the B3 Qualitative Moisture Analysis Worksheets and Glaser calculation or WUFI simulation documentation.
- I.2C: If the project team has determined to use a third-party building enclosure consultant, submit minutes and/or reports from the Construction Documents-phase meetings with the enclosure consultant.

Closeout:

- I.2A: Confirmation that site grading provides proper slope next to the building. Confirmation that installed downspout leaders and/or trench drains lead water away from the building perimeter. Confirmation that all spray irrigation or sprinkler heads do not spray on the building enclosure.
- I.2C: Submit results of the depressurization air leakage test, done in accordance with listed standards and given in terms of cfm/sq. ft. enclosure area at 75 Pa. If the test results are above 0.25 cfm/sq. ft. at 75 Pa, submit documentation from the diagnostic evaluation, air leakage remediation efforts, and the final test results following remediation. If the project team selected to use a third-party building enclosure consultant, submit minutes and reports from the Construction Administration-phase meetings with the enclosure consultant as well as results from the window performance air and water leakage testing.

Additional Resources

ABAA Standard Method for Building Enclosure Airtightness Compliance Testing: http://www.airbarrier.org/technical-information/whole-building-air-tightness-testing-2/.

Building Enclosure Consultant Certification and Training Programs: http://rci-online.org/pro-registrations/registered-building-envelope-consultant-rbec/ and http://besinstitute.com/besi-certifications/.

Building Science Corporation (BSC) Explains the Perfect Wall Concept: https://buildingscience.com/documents/insights/bsi-001-the-perfect-wall.

Dynamic Moisture Modeling Guidance from the Department of Energy (DOE) Building Technologies Office, Strategy Guideline: Modeling Enclosure Design in Above-Grade Walls: https://www.nrel.gov/docs/fy16osti/65479.pdf.

Guideline I.3 Ventilation

Intent

To promote good indoor air quality by implementing appropriate outdoor air ventilation and exhaust systems and limiting the ingress of particulates and soil gases into the building.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations that include replacement or alteration of relevant systems.

A. Ventilation baseline: Design mechanical systems to meet the minimum outdoor air ventilation rates for all mechanically ventilated zones as specified in the current ASHRAE Ventilation Standard 62.1 (or Standard 62.2 for residential buildings).

B. Monitor outdoor airflow rates or perform checks annually to verify ventilation rates are meeting the ASHRAE minimums in all large spaces (1,000 sq. ft. or more) which are high occupancy (25 people or more). Small ventilation systems serving a total of 5,000 sq. ft. or less are exempt from this requirement.

C. Meet ASHRAE 62.1 Air Class (1–4) requirements for recirculation of indoor air and enclose and negatively pressurize the following spaces:

    1. Chemical storage rooms or other areas with identified risk of airborne hazard.

    2. Printer/copier rooms with high volume laser printers, copiers, and multifunctional device (MFDs), (i.e., printing equipment with dry toner). Air from these rooms should be treated as Air Class 4. Laser printers/copiers meeting Blue Angel low emission criteria RAL-UZ 171 are exempted from these requirements and are permitted to be located in an open-office space without triggering exhaust requirements.

D. All mechanical ventilation equipment designed to deliver outdoor air must be equipped with minimum efficiency reporting value (MERV) 11 filters or better. Equipment designed to recirculate indoor air only must be equipped with MERV 8 filters or better. If the specified equipment cannot accept MERV 11 or MERV 8 respectively, specify the highest MERV-rated filter that will fit.

E. Install permanent entryway systems such as walk-off mats or grille or grate systems at least 10 ft. long in the primary direction of travel at all regularly used entrances.

F. Meet the Outdoor Air Intake Minimum Separation Distances as specified in ASHRAE 62.1, Section 5.5 and Chart 5.5.1.

G. Control radon and other hazardous soil gas:

1. For new buildings and additions, control radon and other harmful soil gas by meeting the requirements of ANSI CC-1000: Soil Gas Control Systems in New Construction of Building. This is required for all projects in Minnesota, both EPA Zone 1 and Zone 2. This includes but is not limited to:

    i. Creation of a soil gas collection plenum (this plenum is often a sub-slab gravel or crushed stone bed into which soil gas infiltrates).

    ii. Creation of a continuous sealed barrier between occupied space and the soil gas collection plenum.

    iii. Soil gas vent piping that has the capability to, at minimum, passively vent soil gas from the collection plenum through the roof of the building.

    Testing of radon levels after construction is required; if radon levels are found to be above 2 picocuries per liter (pCi/L) the project must install an Active Soil Depressurization System (ASD) per ANSI CC-1000.

2. For all remodeled buildings and remodeled portions of buildings regardless of type, testing and remediation must be performed as directed in the most relevant of the following standards:

    i. For schools and large buildings: American National Standards Institute Radon Mitigation System for Schools and Large Buildings (ANSI RMS-LB).

    ii. For Multifamily Buildings: American National Standards Institute Radon Mitigation System for Multifamily Buildings (ANSI RMS-MF).

Recommended Performance Criteria

H. Implement a demand-controlled ventilation system.

I. Develop and implement a green cleaning protocol using products that comply with EPA Safer Choice or Green Seal labels.

Meeting the Guidelines

In almost all settings, ventilation with outdoor air is critical to ensure proper indoor air quality. Research has shown that occupant health, cognition, and productivity all benefit from the introduction of fresh air and the exhaust of polluted indoor air. Determining the proper outdoor air ventilation rate is the primary topic of ASHRAE Guideline 62. ASHRAE 62.2 should be used for residential buildings; ASHRAE 62.1 should be used for all others. Below, the most recent version is referred to simply as ASHRAE 62.

In the early design stage, work with the owner to identify the expected occupancy and activity type in all areas of the building, and use these or ASHRAE design occupancy levels to begin ventilation rate calculations. Determine the appropriate ASHRAE procedure for calculating these, either 1) the Ventilation Rate Procedure (VRP), 2) the Indoor Air Quality Procedure (IAQP), or 3) the Natural Ventilation Procedure (NVP). If using the standard VRP, it is recommended to adopt an air distribution configuration such as displacement ventilation that improves the zone air distribution effectiveness and reduces the total zone outdoor airflow. This may also result in reduced energy consumption and help meet SB 2030 energy targets.

Early in the design phase, determine a strategy for controlling emissions from printers, copiers, and MFDs. If these devices will use dry toner, emissions to the air must be contained within an enclosed room and exhausted directly to the outdoors. Alternatives to this approach include using inkjet printers rather than laser printers, or requiring laser printers

to meet the emission certification of Blue Angel RAL-UZ 171. Such printers could be dispersed in an open-office setting, for example.

Throughout mechanical design, the mechanical design team should coordinate with the energy analysis team so that ventilation rates are consistent in both processes. Update the design ventilation rate as any changes are made to the occupancy levels planned for the building. Communicate these changes to the parties evaluating energy performance so that ventilation rates compliant with these guidelines can be taken into account in energy calculations. The SB 2030 program considers ventilation rates in the creation of the SB 2030 Energy Standard; ensuring that these rates are noted allows an appropriate standard to be created.

The mechanical design team should consider using strategies that provide the opportunity to reduce energy use associated with ventilation. The list of recommendations includes but is not limited to:

- Use of CO_2 sensors or other types of occupancy sensors to reduce ventilation in spaces when they are unoccupied.
- Use of ventilation strategies that increase ventilation efficiency such as displacement ventilation.
- Use of economizer cycles where possible.
- Use of heat recovery strategies in the ventilation design chosen.

For many building types, use of these strategies can significantly reduce total energy consumption and help the building achieve challenging SB 2030 energy targets.

For ventilation systems serving over 5000 sq. ft., determine how outdoor airflow will be monitored. Yearly spot checks are allowed, but if continuous monitoring is desired, ensure that air flow can be measured for all large spaces that are high occupancy and that these values are reported to the Building Automation System (BAS) or other tracking and recording device. These systems should be shown on the HVAC plans.

All new buildings, regardless of type or location, must protect against hazardous soil gases, including radon, using at least the passive measures found in the ANSI CC-1000 standard. Radon is a soil gas, and typically enters buildings through air leaks at or below grade. Therefore, passive measures such as the creation of a robust air barrier between the building's at/below grade space and the ground is critical and effective. Further control is offered by passively venting the ground below the building's floor slab. This is typically done with a sub-slab layer of crushed stone and perforated drain tile, which can collect soil gases migrating through the stone layer. These gases are safely routed through a vertical ventilation stack and released above the roof of the building. The ANSI CC-1000 Standards guide engineers on the design, layout, and venting requirements of the sub-slab collection plenum and vent system. Be aware that each vertical ventilation stack can vent only a limited area, and may require space for a powered fan.

Following construction, testing radon levels is also required for all buildings, regardless of type or location. Testing should be performed per CC-1000 Annex D, and be performed for radon and any other hazardous soil gas identified as a risk for the building. If radon levels are found above 2 piC/L, the passive stack ventilation system must be retrofitted with fans to provide a powered ventilation assist. These fans will require extra space for installation and access in case of replacement or maintenance. They will also require a source of electrical power since they must run continuously. Take these issues into consideration at the design stage to minimize expenses if radon testing shows fans are required.

Submittal Requirements

Design:

- I.3E: Submit preliminary building plans showing the location of all primary entrances including space for permanent entryway systems.

Final Design:

- I.3A: Submit ASHRAE 62 calculations for each zone, showing the required and planned ventilation rate in each.
- I.3B: Identify the chosen method for monitoring outdoor airflow rates during operations (permanent monitoring system or annual spot checks) and, if appropriate, submit an HVAC plan identifying the monitoring equipment.
- I.3C: Submit HVAC plans identifying the ASHRAE Air Class of each ventilation zone, along with the ventilation and/or dedicated exhaust systems that will serve them.
- I.3D: Submit HVAC specifications or plans detailing the level of filtration on all mechanical ventilation equipment.
- I.3E: Submit building plans showing the location of all primary entrances and the type and placement of permanent entryway systems.
- I.3F: Submit HVAC plans showing the location of all outdoor air intakes relative to the nearest pollutant or other contaminant sources with notes indicating the distance between them.
- I.3G: Submit building plans showing all critical components of the soil gas control system, including the design and details of the sub-slab collection plenum, air barrier, and size, location, and area served by each vent stack.
- I.3H: Submit HVAC plans and specifications detailing the location and type of equipment and operating parameters of the demand-controlled ventilation system.

Closeout:

- I.3G: Submit results from radon tests within one year of occupancy. If radon levels are measured above 2 piC/L, submit documentation showing installation of fans and/or other components of the ASD.
- I.3A, I.3C, I.3D, and I.3H (Submitted under P.1): Ensure that the mechanical system has been commissioned and documented according to the requirements of Guideline P.1.
- I.3I: Submit a Green Cleaning Protocol that specifies the types of cleaning products and outlines the procedures that will be used to clean the premises.

Occupancy – Submitted annually for ten years:

- I.3B: Annually submit outdoor airflow rates measured for each high occupancy zone (>25 people/1000 sq. ft.) along with the associated ASHRAE 62-calculated minimum rate.

Additional Resources

ASHRAE Standards 62.1 and 62.2: https://www.ashrae.org/resources--publications/bookstore/standards-62-1--62-2.

ANSI CC-1000 Soil Gas Control Systems in New Construction of Buildings: https://aarst-nrpp.com/wp/store/rrnc-for-larger-buildings-cc-1000/, Previous public draft available for review: http://aarst-nrpp.com/wp/wp-content/uploads/2016/09/CC-1000-09-16PubReview.pdf.

Blue Angel-certified laser printer/copier/MFD product listings: https://www.blauer-engel.de/en/products/electric-devices/drucker-und-multifunktionsgeraete and http://h22235.www2.hp.com/hpinfo/globalcitizenship/environment/productdata/lpblueangeluseng.html.

EPA Radon Information: https://www.epa.gov/radon.

EPA Radon Resistant Construction: https://www.epa.gov/radon/radon-resistant-construction-basics-and-techniques#rrct.

Minnesota Radon Testing Kits: http://www.health.state.mn.us/divs/eh/indoorair/radon/radontestresults.html.

US EPA, Radon Zone Map: https://www.epa.gov/radon/epa-map-radon-zones.

Guideline I.4 Thermal Comfort

Intent

To promote occupant thermal comfort through active and passive means, and to provide occupants with the ability to control the conditions in their space.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations that include replacement or alteration of relevant assemblies.

A. Passive thermal comfort

1. Avoid high solar heat gains.

   For regularly occupied spaces with at least one exterior wall facing within 45 degrees of due east or west, limit susceptibility to solar heat gains by employing one or more of the following on at least 95% of glazing within 45 degrees of due west or east:

   i. Specify glazing in those facades with low solar gain glass (solar heat gain coefficient [SHGC] < 0.4).

   ii. Employ frit patterns that achieve SHGC equivalent no greater than 0.4.

   iii. Implement exterior operable shading systems or southern horizontal and easterly and westerly vertical louvers.

2. Avoid radiant temperature asymmetry

   i. For regularly occupied spaces above grade with at least one exterior wall, maintain an area-weighted average U-value for the exterior wall no greater than 0.2, including fenestration and doors.[10] The opaque wall and fenestration/door component U-values can be no greater than those listed in the prescriptive enclosure requirements section of the current version of the applicable energy code (International Energy Conservation Code [IECC] or ASHRAE 90.1).

3. For naturally-ventilated spaces (i.e., without mechanical ventilation equipment), meet the design, operating, and performance criteria of the Adaptive Comfort Model from the current version of ASHRAE 55 Standard.

[10] The U-0.2 limit follows ASHRAE 55 guideline that specifies the U-value at which radiant asymmetry from an exterior wall becomes negligible, and air temperature may be used rather than operative temperature in the comfort calculations.

B. Active thermal comfort[11]

1. Mechanical systems

   i. All mechanically ventilated spaces must have mechanical systems designed to meet the comfort criteria of the current version of ASHRAE 55 during operating hours. Provide documentation of ASHRAE 55 calculations for summer, fall, winter, and spring conditions in a range of spaces including different space types and occupant activity levels. As long as I.2A Part 2i is met, the mean radiant temperature calculation is not necessary for these spaces. Garages, warehouses, vehicle maintenance and repair, ice rinks, and pools are exempted from this requirement.

   ii. Ensure that the mechanical system including ventilation, heating, cooling, and distribution systems are commissioned as required under Guideline P.1 and the requirements of this section are included in the Basis of Design documentation.

2. Occupant controls[12]

   i. Provide locally adjustable thermal comfort controls for at least 50% of single occupant spaces and a control for all shared multi-occupant spaces. Thermal comfort controls allow occupants to adjust at least one of the following: air temperature, radiant temperature, air speed, or humidity.

Meeting the Guidelines

Post-occupancy evaluations of existing B3 buildings have identified occupant thermal comfort as an area in need of significant improvement. High thermal performance enclosures are the first step to improving this comfort with minimal use of additional energy. Better design of mechanical systems to increase occupant control over thermal conditions is also necessary, combined with enhanced commissioning to ensure those controls and systems are working properly.

Early in the design phase, begin evaluating the appropriate window-to-wall area ratio (WWR) abutting regularly occupied spaces. Achieving a WWR above 40% to 50% in those spaces while meeting the area-weighted average U-value requirement under 0.2 will be difficult without using fenestration that surpasses code-level thermal performance. Fixed and operable windows, storefront, and curtainwall systems are available that can achieve U-0.2, but they remain a more expensive option compared to limiting the WWR.

Identifying or calculating the U-value of opaque wall assemblies and fenestration can be difficult in some cases. A simple center-of-cavity or center-of-glass U-value is not adequate to determine thermal comfort because of the strong influence of thermal bridging. In the early design stages, it may be more helpful to use code-prescribed U-values for calculations since actual assemblies and fenestration products may not yet be known. Code U-values for Climate Zones 6 and 7 are provided in the Design-Stage B3 Enclosure Thermal Comfort worksheet. For the final design-stage submission, actual whole-assembly or whole-window U-values must be calculated or provided for the specific assemblies and components which have been selected. Both ASHRAE 90.1 and the IECC Energy Conservation Code contain tables listing the U-values for a range of different opaque wall assemblies and insulation thicknesses. These values are particularly important to use for walls incorporating steel framing elements.

It's important to note that while the ASHRAE 90.1 and IECC tables account for thermal bridging between steel studs, they generally assume any exterior insulation is perfectly continuous. In practice, exterior insulation installed outboard

[11] This guideline is aligned with credits available under the USGBC LEED Building Design and Construction v.4 (LEEDv4), The WELL Building Standard, and the Collaborative for High Performance Schools (CHPS).
[12] This guideline is aligned with credits available under LEEDv4.

of the sheathing is rarely continuous since the cladding needs attachment points to transfer wind and gravity loads to the structure. Often, attachment is provided via a system of metal girts or clips or both, with very significant impacts on the R-value of the exterior insulation. For example, a typical system of horizontal z-girts installed 24 in. on center may reduce the additional R-value of exterior insulation by more than 50%. If exterior insulation is used, the impact of such thermal bridges must be accounted for in the U-value calculations as well. In some cases, manufacturers of proprietary cladding mount systems will have methods or tables to help calculate the R-value reduction due to their girts or clips. If such resources are not available for a particular project, use the Steven Winter Associates Cladding Attachment Thermal Bridging Guide to find the appropriate degradation factor for the exterior insulation (see Additional Resources section, below).

Whole-window U-values for storefront and curtainwall products can also be difficult to provide since they depend strongly on the spacing of the mullions and resulting frame-to-glass ratio. High amounts of window frame tend to drive up the window U-value and decrease the thermal performance of storefront and curtainwall systems since they act as thermal bridges. Some manufacturers will provide a range of U-values representing a range of frame-to-glass ratios. In that case, it is the responsibility of the design team to determine an appropriate U-value from that range, given their fenestration design, or to ask the manufacturer for assistance. Other manufacturers may only provide a single U-value based on a specific window test size and frame-to-glass ratio. In that case, an adjustment to the U-value may be appropriate using experience, judgement, and/or recommendations from the manufacturer. Special, project-specific U-value calculations are possible and encouraged but not required.

Compliance with I.4A Part 2 is verified by submission of a calculation performed for each regularly occupied space with one or more exterior walls. Nonregularly occupied spaces (e.g., hallways, stairways) are exempted from this requirement. Below grade spaces and spaces with less than 30% window and door area can be omitted from the calculations, as long as walls, windows, and doors meet the minimum U-values prescribed in the applicable energy code. A group of identical spaces, or nearly identical spaces, require only one calculation demonstrating compliance for the group. If design values for the opaque wall and fenestration are already known in the design stage, they can be used in conjunction with the Final Design-Stage B3 Enclosure Thermal Comfort Worksheet and submitted in place of the design-stage calculator.

Improving passive thermal comfort with a high quality enclosure is the first step to achieving thermal comfort for occupants. Mechanical systems must be well designed and commissioned in order to maintain comfortable conditions. Anticipated compliance with ASHRAE 55 comfort zones should be verified for a range of representative spaces in summer, fall, winter, and spring conditions. The Center for the Built Environment (CBE) Thermal Comfort Tool, hosted by the University of California, Berkeley, may be used to set desired operating conditions, activity levels, and clothing levels within a space to check for compliance with ASHRAE 55 comfort requirements. As long as Guideline I.4A Part 2 is met, the mean radiant temperature of all regularly occupied space will be sufficiently close to the indoor air temperature. In this case, the indoor air temperature can be used as the operative temperature, eliminating the need to calculate mean radiant temperature. A link to the CBE Tool is provided in the Additional Resources section.

Since thermal comfort is subjective and dynamic, a mechanical system that can provide the conditions to satisfy ASHRAE 55 is not a guarantee of thermal comfort for all occupants all the time. Research studies have shown that occupants feel more comfortable and satisfied with their space when given the means to control at least some of the factors that influence thermal comfort. These include air temperature and radiant temperature, air speed, and humidity. Ideally, every occupant should be given thermal comfort controls allowing them to adjust at least one of these factors, but this may be cost-prohibitive or not feasible given some types of mechanical systems. However, every mechanical system should be designed to provide locally adjustable comfort controls for every shared multi-occupant space and at least

50% of individual occupant spaces. Individual occupant spaces are enclosed or nearly enclosed spaces occupied most regularly by a single person. These requirements are best considered early in the design of the mechanical systems of the project.

Submittal Requirements

Design:

- I.4A2: Submit building elevations showing the preliminary window and opaque wall surface areas. Submit the Design-Stage B3 Enclosure Thermal Comfort Worksheet, documenting the area-weighted average U-value of each exterior wall abutting a regularly occupied space and assuming code-compliant wall attributes.
- I.4A3: For all naturally-ventilated zones, submit preliminary building plans showing the planned airflow paths through each space.

Final Design:

- I.4A1: Submit documentation from the glazing manufacturer documenting the SHGC value of the glass used on east- and west-facing exposures is less than or equal to 0.4. If shading devices are used to meet this requirement, submit building elevations showing shading devices instead of SHGC values.
- I.4A2: Submit building elevations showing the window and opaque wall surface areas. For window, door and spandrel components, submit manufacturer literature documenting the U-value for each of these components. Submit Final-Design B3 Enclosure Thermal Comfort Worksheet, documenting compliant wall assemblies.
- I.4A3: Submit ASHRAE 55 Adaptive Comfort Model calculations for all naturally-ventilated zones or sufficient representative spaces.
- I.4B1: Verify that the mechanical system can meet the comfort requirements of ASHRAE 55 for summer, fall, winter, and spring conditions in a range of different space types with different occupant activity levels using the CBE Thermal Comfort Tool, and document using the “LEED Documentation” option.
- I.4B2: Submit building plans showing the location of all local thermal comfort controls, individual occupant spaces, and shared multi-occupant spaces, indicating which of the individual occupant spaces contain thermal comfort controls and identifying the thermal comfort control for all shared multi-occupant spaces.

Additional Resources

CBE Thermal Comfort Tool for Use with ASHRAE 55: http://comfort.cbe.berkeley.edu/.

IECC 2015 U-value Requirements for Opaque Walls and Fenestration: https://codes.iccsafe.org/public/document/IECC2015/chapter-4-ce-commercial-energy-efficiency and https://codes.iccsafe.org/public/document/IECC2015/chapter-4-re-residential-energy-efficiency.

Morrison Hershfield – Thermal Bridging in Exterior Insulated Steel Stud Assemblies: http://blog.morrisonhershfield.com/insights/solutions-mh-thermal-bridging-in-exterior-insulated-steel-stud-assemblies.

Parallel Paths Method Wall U-value Calculator, for Wood-Framed Walls Only: https://www.appliedbuildingtech.com/fsc/calculator.

RDH Technical Bulletin – Cladding Attachment Solutions for Exterior Insulation Commercial Walls: http://rdh.com/wp-content/uploads/2015/12/TB-11-Cladding-Attachment-Solutions-Dec-16-15-FINAL.pdf.

Steven Winter Associates – Cladding Attachment Thermal Bridging Guide for Exterior Insulation: https://www.b3mn.org/swa-cladding-attachment-thermal-bridging-guide-for-exterior-insulation/

Glossary

Regularly Occupied Space:

Any space that is occupied by one or more persons for more than one hour during days the building is in use. Note that this includes spaces which may be irregularly occupied but, when occupied, a typical occupant would spend more than one continual hour in the space. Excluded from calculation of continuously occupied spaces are:

- Spaces with uses that only require minimal lighting and in which the primary activity intended for the space would be harmed by daylight (this exclusion does not apply to spaces with ultraviolet light concerns) – note that this only applies to the calculation of regularly occupied spaces with respect to the daylighting requirements.
- Spaces that do not meet the minimum occupancy outlined above during daylight hours) – note that this only applies to the calculation of regularly occupied spaces for the daylighting criteria with respect to the daylighting requirements.
- Spaces where no individual occupant spends at least one continual hour during days the building is in use.

Guideline I.5 Lighting and Daylighting

Intent

To promote occupant comfort by providing adequate levels of natural and artificial light to maintain sufficient light levels for tasks being performed. Quality lighting can also support cognitive function, mental health, and social interaction while being aesthetically pleasing and complementing the design of the space.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations which include replacement or construction of relevant systems and assemblies.

A. Light levels:[13]

1. Provide adequate light levels according to Illuminating Engineering Society (IES) guidelines not including daylighting contributions for regularly occupied spaces. These light levels shall be:
    i. Measured at task plane.
    ii. Maintain contrast levels by demonstrating one of the following:
        (1) Average wall surface to average work surface illuminance level ratio: 1:3.
        (2) Average ceiling surface to average work surface illuminance level ratio: 1:10.

B. Lamp specifications:[14]

1. Use light sources with a color rendering index (CRI) of at least 80, unless necessary for special use.
2. All light sources should be Restriction of Hazardous Substances (RoHS) compliant following the most current European RoHS requirements

C. Daylighting:

1. On facades facing within 45 degrees of east, south or west: provide glare control devices with manual operation (or automatic with manual override) for 90% of all regularly occupied spaces.
2. Demonstrate daylight utilization with one of the following:
    i. Demonstrate achievement of spatial daylight autonomy (sDA) for at least 50% of regularly occupied spaces.
    ii. Demonstrate that daylight alone provides illuminance levels within 20% of IES recommendations for 75% of regularly occupied spaces at 9 a.m. and 3 p.m. on a clear-sky day at the equinox.
    iii. Demonstrate achievement of a daylight factor of at least 2% in 80% of regularly occupied spaces.[15]

Recommended Performance Criteria

D. Use light sources with a CRI of at least 90.

[13] This guideline is aligned with credits available under LEEDv4.
[14] This guideline is aligned with credits available under LEEDv4, The WELL Building Standard, and CHPS.
[15] This guideline is aligned with credits available under the BREEAM program.

E. Light direction and glare: Use direct-only overhead lighting for 25% or less of total connected lighting load in all regularly occupied spaces.[16]

F. Interior surface reflectance: Specify interior surfaces (walls, floors, ceilings, permanently installed furniture) for all regularly occupied spaces that meet or exceed the following area-weighted average reflectance values to maximize lighting efficiency and to increase the perceived brightness of spaces:

   1. Ceilings: at least 85% average surface reflectance.
   2. Walls: at least 60% average surface reflectance.
   3. Floors: at least 25% average surface reflectance.
   4. Furniture:
      i. At least 45% average surface reflectance for work surfaces.
      ii. At least 50% average surface reflectance for movable partitions.

Meeting the Guidelines

During schematic design, work with owner/client to understand electric lighting needs and develop a strategy to meet needs while conserving energy and maintaining a high environmental quality. For each regularly occupied interior space, establish and document the light levels recommended for primary (and secondary) use type using B3 Lighting Space Tracking Worksheet.

Calculate target levels to maintain contrast ratios between spaces and surfaces as described above. For contrast ratios between work surfaces and wall surfaces (excluding fenestration), use the following calculation for illuminance ratio:

$$1:\left(\frac{Average\ work\ surface\ illuminance}{Average\ wall\ surface\ illuminance}\right)$$

For example, if the target average work surface illuminance is 40fc, the target wall surface illuminance should be at least 13fc to maintain the desired 1:3 ratio.

For contrast ratios between work surfaces and ceiling surfaces (excluding fenestration) use the following calculation for illuminance ratio:

$$1:\left(\frac{Average\ work\ surface\ illuminance}{Average\ ceiling\ illuminance}\right)$$

For example, if the target average work surface illuminance is 40fc, the target ceiling surface illuminance should be at least 4fc to not exceed the 1:10 ratio.

Establish criteria for and document the interior surface reflections, based on manufacturer cutsheets, reflectance chart, or by using the calculation methodology described in IES Lighting Handbook. Specify the light fixture direction and lensing if following Recommended Guideline I.5F, Light Direction and Glare.

During design development and in construction documents, simulate electric lighting to confirm desired light levels at appropriate height, including wall or ceiling illuminance to confirm contrast ratios, and document results. Simulation of light levels should be completed for all regularly occupied spaces, and simulations should accurately reflect interior

[16] This guideline is aligned with credits available under LEEDv4.

surface reflectance and include permanently installed furniture that may affect light levels. If needed, adjust lighting strategy to meet goals established in previous step. If not simulating electric lighting, verify installed light levels after construction but prior to occupancy. Measure and document light levels and address any over or under-lit conditions by changing lamps or fixtures, providing supplemental light, adjusting lighting controls, or other lighting system modifications. Measurements should be taken after surface finishes are applied and with permanent furniture installed.

During schematic design and design development, simulate the daylighting utilization in main spaces. Ensure that daylight models accurately reflect room size, height, window placement, glazing properties, interior surface reflectance, and permanently installed furnishings. If none of the following targets can be met, adjust the design to ensure compliance.

There are several daylighting metrics that may be used to comply with the B3 Guidelines and which are available as outputs daylight modeling software:

- Spatial daylight autonomy (sDA) is an annual measure that determines the percentage of the floor area that receives the minimum light level required for at least 50% of the occupied hours. The threshold for sufficient daylight will be determined based on the recommended IES light levels for the program of the space.
- Point-in-time daylight calculations to confirm light levels within 20% of IES recommended levels for 75% of regularly occupied floor area should be done at 9 a.m. and 3 p.m. on the equinox.
- Daylight factor is the ratio of the illumination available inside a structure to the illumination outside, based calculated or measured from an overcast sky condition.

Compliance with this guideline may be documented using simplified daylight modeling software (e.g., Sefaira) which does not permit reflectance of materials if the following minimum area-weighted surface reflectance is achieved:

- 80% ceilings
- 50% walls
- 20% floors

When selecting and/or specifying light fixtures, ensure that the criteria of CRI and RoHS compliance are met or mandated in specifications. This information can typically be found on manufacturers cutsheets.

If following Recommended Guideline I.5E, evaluate lighting plans and identify spaces with direct-only overhead lighting. Calculate the total connected lighting load in area served by the direct-only overhead lighting, and if direct-only overhead lighting exceeds 25% of the total connected load, select different fixtures to meet the criteria.

If following Recommended Guideline I.5F, select or specify interior surfaces with reflectance to meet or exceed the values listed. This information can be found on manufacturer specifications, typically listed as a fraction of percentage light reflectance or light reflectance value. If the manufacturer’s data does not include reflectance, use the methodology described in the IES Lighting Handbook to calculate the surface reflectance with a product sample or installed product.

Submission Requirements

Design:

- I.5A: Submit preliminary list of space's IES levels and achieved measurements and maximum identified contrast ratios.
- I.5C: Submit preliminary daylight map or table of regularly occupied spaces documenting compliance with one of the listed paths.

Final Design:

- I.5A: Submit final list of space's IES levels and simulated lighting level achieved by the designed lighting, including maximum identified contrast ratios.
- I.5B: Submit lighting schedule and specifications including a requirement for CRI of 80 and RoHS compliant fixtures.
- I.5C: Confirmation of inclusion of required daylight control devices. Final design daylight map, graphic, or table of regularly occupied spaces documenting compliance with one of the listed paths, including a surface area calculation of average reflectance if using simplified daylight modeling.
- I.5D: Submit lighting schedule and specifications including requirement for CRI 90.
- I.5E: Submit a narrative describing location and amount of direct-only overhead lighting.
- I.5F: Submit a narrative describing interior surface reflectance for each item listed.

Closeout:

- I.5A: If not documenting simulated lighting levels provide a list of regularly occupied spaces, IES levels and measured lighting levels, and maximum identified contrast ratios.
- I.5B: Provide documentation of installed light fixtures and compliance with RoHS.

Additional Resources

Architecture 2030 Palette – Daylighting Patterns and Guidance: http://2030palette.org/.

Building Energy Software Tools Directory (lists several hundred types of building analysis tools available to the designer, with a section on lighting, many of which include daylighting capabilities): http://buildingenergysoftwaretools.com/.

Efficient Windows Collaborative (contains references, resources and simulation tools for window design and selection for daylighting): www.efficientwindows.org.

IES Lighting Handbook, 10th Edition – Electric Light Level Recommendations, Surface Reflectance Guidance: https://www.ies.org/store/lighting-handbooks/lighting-handbook-10th-edition/.

Radiance Lighting Engine: www.radiance-online.org and https://www.energy.gov/eere/buildings/downloads/radiance.

Sefaira – Dynamic Daylighting Metrics (explanation of the calculation of dynamic daylighting metrics): http://sefaira.com/resources/measuring-daylight-dynamic-daylighting-metrics-what-they-mean-for-designers/.

Windows for High Performance Buildings (contains references, resources and simulation tools for window design and selection for daylighting): www.commercialwindows.org.

Velux Daylight Visualizer: http://www.velux.com/article/2016/daylight-visualizer.

Glossary

Regularly Occupied Space:

Any space that is occupied by one or more persons for more than one hour during days the building is in use. Note that this includes spaces which may be irregularly occupied but, when occupied, a typical occupant would spend more than one continual hour in the space. Excluded from calculation of continuously occupied spaces are:

- Spaces with uses that only require minimal lighting and in which the primary activity intended for the space would be harmed by daylight (this exclusion does not apply to spaces with ultraviolet light concerns) – note that this only applies to the calculation of regularly occupied spaces with respect to the daylighting requirements.
- Spaces that do not meet the minimum occupancy outlined above during daylight hours) – note that this only applies to the calculation of regularly occupied spaces for the daylighting criteria with respect to the daylighting requirements.
- Spaces where no individual occupant spends at least one continual hour during days the building is in use.

Guideline I.6: Effective Acoustics

Intent

To promote productive, supportive, and comfortable acoustic environments for all occupants and to control unwanted noise. Effective acoustics enable effective speech communications at normal speaking voice while providing for local speech privacy.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations that include replacement or construction of relevant assemblies.

A. Newly constructed and renovated classrooms and other education facilities, including both spaces classified as occupancy group[17] E and other learning spaces and facilities for students above the 12th grade must follow ANSI S12.60–2010 Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools.

B. Exterior-source noise control: All buildings or spaces not covered under I.6A must meet at least one of the following:

   1. A-weighted exterior-source background noise in regularly occupied spaces of the building shall be no greater than 45dBA, as evaluated after construction but prior to occupancy and tested per Annex A of ANSI S12.60–2010 Part 1.

   2. Average Outdoor-Indoor Transmission Class (OITC) rating of facades and roof assemblies shall be at least 30, or at least 40 for sites with identified risk of significant exterior-source noise. These sites include:

      i. Sites within mapped 60 dBA Day-Night Level (DNL) area for airports listed below.

      ii. Sites with an identified A-weighted outdoor noise level of 65dBA or greater as surveyed during planned occupied times and evaluated as equivalent energy level (Leq) for a period of one hour during loudest time of the day.

      iii. If the project includes residential use and the site has a DNL or Community Noise Equivalent Level (CNEL) of 45dBA or greater.

[17] Occupancy groups listed here are defined in the most recent version of the International Code Council's International Building Code.

C. Internal-source noise control: For buildings or spaces not covered under I.6A:

Meet all of the following:[18]

1. Air-distributed noise level from mechanical system must not exceed the following Noise Criteria (NC) levels, as estimated through the most current version of HVAC Applications HVAC Handbook, Chapter 48, Noise and Vibration Control; Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 885-2008 methodology; or ANSI S12-60 Part 1 Annex A.1.
    i. Gymnasia, circulation spaces, lobbies, service areas, and sports facilities with or without seating areas: maximum of NC 45.
    ii. Meeting, lecture halls not part of occupancy type E, offices of less than 300 sq. ft., and conference rooms: maximum of NC 35.
    iii. All other spaces: maximum of NC 40.
2. Reduce interior noise transfer through the following:
    i. Wall and floor/ceiling assemblies between occupancies achieves a Sound Transmission Class (STC) of at least that listed in the table below. If Apparent Sound Transmission Class (ASTC) ratings are used, subtract 5 from the listed STC minimums to determine ASTC minimums. If Normalized Noise Isolation Class (NNIC) is used for field verification, subtract 3 from the listed STC minimums.

    Note that Group E occupancies are covered under I.6A above.

    Minimum STC ratings for regularly occupied portions of adjacent occupancy groups:

	A	B	F	I	M	R
A	60	60	60	60	60	60
B	60	50	60	50	50	50
F	60	60	60	60	60	60
I	60	50	60	50	50	50
M	60	50	60	50	50	50
R	60	50	60	50	50	50

    Assemblies adjacent to circulation spaces may reduce the STC requirements by 5. Spaces not regularly occupied are exempt from this requirement.

[18] This guideline is generally aligned with the method proscribed by the 2015 International Green Construction Code, though it differs on the threshold for open floor offices.

Adjacent regularly occupied spaces within occupancies shall meet the following minumums:

	Minimum STC for assemblies within occupancy group
A	55
B	45
F	50
I	45
M	45
R	45

ii. Impact Isolation Class (IIC) of floor and ceiling assemblies separating sleeping areas or dwelling units from other sleeping areas or dwelling units or other occupancies is at least 50. Assemblies separating sleeping areas or dwelling units from storage, including Group A-4 and Group S are exempt from this requirement.

iii. Ensure the following are included in the design and verified during construction:

(1) Walls continue and are sealed to bottom of floor/ceiling structure for those assemblies serving as acoustic barriers

(2) Other penetrations of intended sound barriers are limited.

(3) Consideration of other equipment or noise that will be present in the space and will be active during occupied hours. Consider separation of equipment likely to interfere with productive and comfortable acoustic environments.

iv. Ensure that wall, floor/ceiling assemblies separating mechanical rooms from other areas of the building achieve at least an STC rating of 50. If the mechanical space includes a generator, compressor, or other similar noise source, achieve an STC of at least 60 in surrounding wall and floor/ceiling assemblies. Ensure that mechanical equipment is adequately isolated to limit structure-borne sound and vibration transmission. Ensure that plumbing equipment has been adequately isolated from spaces to prevent noise transmission and noise production.

3. Room acoustics: All regularly occupied spaces must meet one of the three paths listed below subject to the noted exceptions:

i. Calculated reverberation time as evaluated for the 500 Hz, 1000 Hz, and 2000 Hz octave bands must be no less than 0.2 seconds and no greater than 0.7 seconds. This calculation may include furnishings if included in the project.

ii. The average area-weighted noise-reduction coefficient (NRC) of all of the interior surface materials or assemblies of the space is greater than 0.45. This calculation may include furnishings if included in the project.

iii. The average area-weighted NRC of all of the interior surface materials or assemblies of the space is greater than 0.35 for spaces with volumes less than 30,000 cu. ft. This calculation may include furnishings if included in the project.

Exceptions:

- Concert halls or other music performance auditoria, laboratory spaces, aquatic facilities, and gymnasia are exempt from this requirement.
- Open-office floor plans may have a reverberation time of up to 0.8 seconds or an area-weighted NRC as low as 0.30.

D. Adequate acoustic conditions of gathering spaces and accommodation for hard-of-hearing: This is coordinated with Minnesota Statute §16C.054. For all spaces which accommodate and are intended for gatherings of 15 or more people and where audible communications is integral to the use of the space:

1. Include audio-induction loops to provide an electromagnetic signal for hearing aids and cochlear implants if a permanent audio amplification system is present in the space.
2. The space must meet the American National Standards Institute Acoustical Performance Criteria, Design Requirements and Guidelines for Schools for:
    i. Maximum background noise
    ii. Reverberation times

E. Implement sound masking if any of the following condition are met:[19]

1. Internal-source noise control: Projects which are not compliant with I.6A, I.6B, or I.6C.
2. Spaces which have been identified as requiring additional sound privacy, or where the productivity benefits of sound masking are desired in areas that are anticipated to be over-quiet.

Sound masking system should not exceed 45dBA and should be broad spectrum.

Recommended Performance Criteria

F. Confirm performance under I.6A for educational facilities by performing noise measurement as outlined under ANSI/ASA S.12.60-2010 Annex A.

G. Articulation Index (AI) must be less than 0.30 for open offices, where speech privacy is desired, and greater than 0.70 for enclosed offices or other spaces where a high level of speech intelligibility is desired. Compliance with this requirement involves:
1. Identification of at least two areas of indented speech privacy and areas of desired communicability.
2. Documentation that the design meets the AI for these identified spaces.

Meeting the Guidelines

Indoor acoustic environments have been identified as an area many surveyed occupants find dissatisfactory. Improving the indoor acoustic condition is generally done by the consideration of controlling noise (i.e., unwanted sound) and by supporting the transfer or reverberation of desired sound. As the appropriate level of these criteria varies with different outdoor conditions, occupancy types, noise source and space types, there are an array of strategies necessary to help ensure a productive, supportive, and comfortable indoor environment.

Early in the design process identify which of the guidelines will be required for each room and wall/room assembly. Develop a list of occupancy types if more than one occupancy type is present in the project. In particular, note that education spaces (occupancy type E) and other classroom and learning environments must meet the listed ANSI Standard, which includes requirements for core learning spaces (under 20,000 cu. ft.) and ancillary learning spaces. List

[19] Similar to credit available under LEEDv4.

specific room criteria for each of the space types (i.e., classrooms, conference rooms, etc.) and verify that the anticipated schedule of finishes, wall, and floor/ceiling types will be anticipated to meet these criteria. Adjust design as necessary to meet criteria, including reverberation time, AI (if pursuing I.6G), and sound insulation requirements of interior and exterior wall and floor/ceiling assemblies. List anticipated wall types expected to be used in the project and ensure that they meet the sound insulating requirements laid out in I.6A through I.6C.

Evaluation of the noise present on the site may be done by use of an integrating-averaging sound level meter, which can record and evaluate the sound on the site. This measurement can be used both for the evaluation of Leq levels and DNL levels to determine if OITC ratings must be addressed. Currently the only available airport DNL mapping is the Minneapolis-Saint Paul International Airport (MSP), which is listed below under Additional Resources.

Calculation of airborne noise from HVAC systems may be done per the AHRI 885 methodology using the spreadsheet-based calculator listed below (under Additional Resources) for air terminal units or by using the ASHRAE methodology listed for other system types. Here the source noise and effect of duct size, characteristics and distribution is used to calculate the NC in the resulting space. This additionally permits designs that test with NC over the allowable limit to quickly evaluate potential remedies that would bring the receiving space into compliance. Use of this calculation method may influence duct sizing and layout and as such is best done as early as feasible in the design and mechanical layout process to avoid redesign. Projects may evaluate compliance with I.6C.1 based on representative spaces rather than calculating each room in the project.

Limiting undesirable long reverberation times in larger, more “live” spaces may necessitate additional consideration of interior finishes and furnishings. Projects may evaluate the design of representative spaces for reverberation times if their interior finish materials are predominately the same and square footages and ceiling heights are within 20%. Areas with different floor or ceiling finish types may not be considered to be acoustically representative. Smaller spaces may be able to meet the reverberation time requirements with a lower average NRC through a calculation of reverberation time than they can through the prescriptive approach through I.6C Part 3ii. A simple reverberation time calculator is listed below under Additional Resources.

Include performance criteria necessary to meet guideline requirements in the construction drawings and specifications of the project. Ensure that details have been developed that avoid sound transmission. Note that uncontrolled sound transfer can easily occur at the joint of wall/ceiling assemblies if not properly detailed, and at the connection of interior to exterior wall assemblies.

Submittal Requirements

Predesign:

- I.6B: Identification of whether the project is a high-risk outdoor noise environment.

Design:

- I.6A: Identification of spaces required to meet guideline, if any. Provide list of spaces identified as core learning spaces and ancillary learning spaces with background noise level, reverberation time, and other room and assembly acoustic criteria as defined in ANSI Standard. List the A-weighted outdoor noise level as measured under Part 5.4.1.1 of the guideline and the resulting OITC requirement.
- I.6B: Identification of whether the project is high-risk outdoor noise environment, included documentation of selected method of compliance, including enclosure OITC rating.

- I.6C: List preliminary wall types and wall/ceiling assemblies in project compliant with STC rating requirements. List rooms in project and preliminary assessment of reverberation times and NC. List spaces identified as exempt from reverberation time requirements. If multiple spaces have generally equivalent size, wall assemblies, and finishes, then representative calculations can serve in lieu of calculation of every space in the project.
- I.6D: List gathering spaces of project which trigger guideline requirements and preliminary planning for required system and noise control.

Final Design:

- I.6A: Identification of spaces required to meet guideline, if any. Provide list of spaces identified as core learning spaces with background noise level, reverberation time and other room and assembly acoustic criteria as defined in ANSI Standard. List the A-weighted outdoor noise level as measured under Part 5.4.1.1 of the guideline and the resulting OITC requirement.
- I.6B: Identification of whether the project is a high-risk outdoor noise environment, included documentation of selected method of compliance, including enclosure OITC rating.
- I.6C: List wall types and floor/ceiling assemblies in project compliant with STC rating requirements. List rooms in project and assessment of reverberation times and NC. List spaces identified as exempt from reverberation time requirements. If multiple spaces have generally equivalent size, wall assemblies, and finishes, then representative calculations can serve in lieu of calculation of every space in the project.
- I.6D: List gathering spaces of project which trigger guideline requirements. Describe design of induction loop system and evaluation of reverberation time and outdoor noise control for required spaces.
- I.6F: List open and enclosed office spaces and anticipated AI.

Closeout:

- I.6A: Verification of installed condition meets requirements for core and ancillary learning spaces.
- I.6B: Verification of final enclosure OITC rating(s).
- I.6C: Verification that installed wall types and wall/ceiling assemblies in project compliant with STC rating requirements. Verification or updating of calculated reverberation times based on installed condition.
- I.6D: Verification of installation of required systems.
- I.6E: Documentation of verification of conformance with ANSI/ASA S.12.60 per Annex A.
- I.6F: List open and enclosed office spaces and measured AI (if documenting compliance through measurement).

Additional Resources

AHRI 885 Calculator (calculates the discharge, radiated, and room sounds for various duct sizes and arrangements using AHRI 885 methodology): http://www.ahrinet.org/App_Content/ahri/files/standards%20pdfs/EXCEL%20Docs/AHRI%20Standard%20885-2008%20Duct%20Discharge%20Calculation%20Spreadsheet.xls.

IRCAM (French research project with useful publications and free software): www.ircam.fr.

SARA (Spatial Audio & Room Acoustics Project from the Academy of Finland): www.acoustics.hut.fi/~vpv/projects/sara.htm.

The Engineering Toolbox Architectural Acoustic Calculator: http://www.engineeringtoolbox.com/room-absorption-sound-d_69.html.

Minneapolis-Saint Paul 2017 International Airport (MSP) 2017 Annual Noise Contour Report: https://www.macnoise.com/pdf/final-msp-2017-annual-noise-contour-report-web.pdf.

ODEON Room Acoustics Modeling Software: www.odeon.dk.

Glossary

Regularly Occupied Space:

Any space that is occupied by one or more persons for more than one hour during days the building is in use. Note that this includes spaces which may be irregularly occupied but, when occupied, a typical occupant would spend more than one continual hour in the space. Excluded from calculation of continuously occupied spaces are:

- Spaces with uses that only require minimal lighting and in which the primary activity intended for the space would be harmed by daylight (this exclusion does not apply to spaces with ultraviolet light concerns) – note that this only applies to the calculation of regularly occupied spaces with respect to the daylighting requirements.
- Spaces that do not meet the minimum occupancy outlined above during daylight hours) – note that this only applies to the calculation of regularly occupied spaces for the daylighting criteria with respect to the daylighting requirements.
- Spaces where no individual occupant spends at least one continual hour during days the building is in use.

Guideline I.7 View Space and Window Access

Intent

To provide focal relief and promote a connection the outdoor environment. A distant interior focal point-of-view to the outdoors can help reduce eyestrain and dry eyes from computer-based work, and building occupants who can connect to the outdoors experience greater productivity, attentiveness, and satisfaction. Outdoor views also provide a connection to environmental cues that support natural circadian rhythms.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations that include replacement or construction of relevant assemblies.

A. For focal relief, provide a direct line of sight to vision glazing or interior focal point for 75% of all regularly occupied floor area. Area contributing to the 75% requirement should include a view of objects at least 25 ft. from occupant location.

B. To foster a connection to the outdoor environment, provide direct or borrowed access to vision glazing in 75% of all regularly occupied spaces. Vision glazing must have a clear and unobstructed view to the exterior and include at least one of the following:

    1. Movement (may be vehicular or human movement outside of subject area)
    2. Flora
    3. Fauna
    4. Sky
    5. Water

Recommended Performance Criteria

C. Foster a connection to the outdoor environment by providing direct or borrowed access to vision glazing in all regularly occupied spaces. Vision glazing must have a clear and unobstructed view to the exterior and include at least one of the following:

    1. Movement (may be vehicular or human movement outside of subject area)
    2. Flora
    3. Fauna
    4. Sky
    5. Water

D. Provide operable windows:

    1. In offices, all workstations should be within 30 ft. of an operable window.
    2. Provide operable windows in all dwelling units.

Meeting the Guidelines

During Predesign and schematic design, work with client to identify desirable outdoor views. If no desirable views are possible, consider an interior courtyard space. As design progresses, consider the placement of program spaces as they relate to views to the exterior or to an interior courtyard. As floorplans are developed, note the floor areas in regularly

occupied spaces and the corresponding requirements for access to vision glazing. Map sightlines and floor area with view access. Include permanently installed furniture in consideration of sightlines and views. If following recommended performance criteria, identify which facades or window areas can be operable, and arrange program spaces to provide access to operable windows from workstations and in dwelling units.

Submission Requirements

Design:

- I.7A: Submit preliminary inventory of regularly occupied floor area, and identify sight lines to focal points at least 25 ft. from occupant location(s).
- I.7B and I.7C: Create preliminary plan indicating floor area served, vision glazing contributing to compliance, and view availability of at least one of the listed items.

Final Design:

- I.7A: Submit final design inventory of regularly occupied floor area, and identify sight lines to focal points at least 25 ft. from occupant location(s).
- I.7B and I.7C: Create final design plan indicating floor area served, vision glazing contributing to compliance, and view availability of at least two of the listed items.
- I.7D: Create plan demonstrating workstation distance to operable windows for regularly occupied spaces and in dwelling units if provided.

Glossary

Borrowed Views:

Exterior view achieved through another interior space, particularly through transparent or partial height workstation and room partitions.

Regularly Occupied Space:

Any space that is occupied by one or more persons for more than one hour during days the building is in use. Note that this includes spaces which may be irregularly occupied but, when occupied, a typical occupant would spend more than one continual hour in the space. Excluded from calculation of continuously occupied spaces are:

- Spaces with uses that only require minimal lighting and in which the primary activity intended for the space would be harmed by daylight (this exclusion does not apply to spaces with ultraviolet light concerns) – note that this only applies to the calculation of regularly occupied spaces with respect to the daylighting requirements.
- Spaces that do not meet the minimum occupancy outlined above during daylight hours) – note that this only applies to the calculation of regularly occupied spaces for the daylighting criteria with respect to the daylighting requirements.
- Spaces where no individual occupant spends at least one continual hour during days the building is in use.

Vision Glazing:

Vision glazing refers to glazing which permits an unobstructed view to the exterior. Typical vision glazing does not have perceptible tint or other modification that would impede these views and is installed between 2.5 ft. and 7.5 ft. above the floor height.

Guideline I.8 Ergonomics and Physical Activity

Intent

To promote spatial conditions conducive to incidental physical activity. Movement helps maintain cardiovascular fitness, mental alertness, and encourages interactions that improve morale and well-being. Quality ergonomic design reduces the risk of workplace-related injury and increases productivity.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations that include relevant project scope.

A. If workstation furniture is included as part of the project, provide sit-stand desks that are available to all employees and in at least 25% of workstations. Workstations may be height adjustable or equipped with height adjustment stands.

B. Provide workstation seating with adjustable chair height, seat depth, and at least one of the following: adjustable seat angle, adjustable backrest angle, fully or partially adjustable armrests, or adjustable lumbar support.

C. On project sites with access to existing nonmotorized transportation infrastructure, provide the following secure storage:

   1. Storage within 650 ft. of main building entrance for at least 5% of regular building occupants.
   2. Storage within 650 ft. of main building entrance for at least 2% of building visitors.

D. Promote the use of stairs by providing at least one staircase that is easy to locate for building occupants and visitors, accesses all regularly occupied floors and building main entrance, and is aesthetically pleasing. This staircase may be an enclosed egress stair.

Recommended Performance Criteria

E. In buildings with more than ten regular occupants, provide showers, changing facilities, and lockers for a minimum of 1% of all regular building occupants.[20]

F. Provide outdoor recreation area/open space greater than or equal to 30% of total site area that is accessible to all regular occupants of building.

G. To foster connection to neighborhood, select sites:[21]

   1. With a building site Walk Score of at least 70.
   2. Located within a maximum of one-third mile from at least five basic services, such as a supermarket, hardware store, bank, and food establishments.
   3. Where sidewalks and bike lanes can be extended from building to edge of site to connect to existing and planned pedestrian paths.

[20] This guideline is aligned with credits available under the Fitwel Certification Program, LEEDv4, and The WELL Building Standard.
[21] This guideline is aligned with credits available under the Fitwel Certification Program, CHPS, and The WELL Building Standard.

H. Signage and education:[22]

1. Provide point-of-decision prompts promoting use of stairs rather than elevator.
2. Provide signage of walkable and bikeable attractions nearby.

Meeting the Guidelines

During design, work with owner to establish goals and priorities for ergonomics of workspaces within the project. Identify the number of adjustable workstations required, where they will be located, and who will use them.

Identify the number of regular building occupants and anticipated visitors, calculate nonmotorized vehicle parking requirements, and locate nonmotorized vehicle parking in secure area.

If project has multiple levels, establish a staircase to be visible and enticing. This stairway may also function as egress stair. Design and document features of stairwell.

If pursuing Recommended Criteria I.F, identify need for showers and changing facilities in the project and establish space and fixtures required.

If pursuing Recommended Criteria I.G, calculate required outdoor recreation area and locate the recreation area on the site. Provide accessible routes to recreation area.

If pursuing Recommended Criteria I.H, during site selection, compare potential project sites on https://www.walkscore.com and map nearby basic services. During design, establish site setbacks or other limitations on sidewalks and bike lanes, document site circulation strategy as it relates to general public circulation.

If pursuing Recommended Criteria I.H, create visually appealing and clearly understandable graphics promoting use of stairs rather than elevator for those able. Create visually appealing and clearly understandable graphic showing nearby attractions, particularly those in the walkable (.25–.5 mile) and bikeable (2.5 miles) area.[23]

Submission Requirements

Design:

- I.8A: Planned standing height desk selection and number available to occupants.
- I.8B: Planned workstation seating selection.
- I.8C: Preliminary site or building plan indicating location(s) for nonmotorized vehicle parking.
- I.8D: Preliminary building plan indicating stair location, narrative description of measures implemented to improve visibility and desirability.
- I.8E: Preliminary building plan indicating location of showers, changing facilities, and lockers meeting guideline requirements.
- I.8F: Preliminary site indicating outdoor recreation area.
- I.8G: Documentation of connection to neighborhood, including Walk Score, diagram of nearby services, site plan indication connections achieved and outdoor recreation area meeting minimum site percentage requirements.

[22] This guideline is aligned with credits available under the Fitwel Certification Program.

[23] Distances listed derived from "Creating Walkable and Bikeable Communities" US Department of Housing and Urban Development – Office of Policy and Research. Dec 2016

Final Design:

- I.8A: Description of standing height desk selected and number available to occupants, including specifications or purchasing requirements listed.
- I.8B: Description of workstation seating selected, including specifications or purchasing requirements listed.
- I.8C: Final site or building plan indicating location(s) for nonmotorized vehicle parking.
- I.8D: Final building plan indicating stair location, narrative description of measures implemented to improve visibility and desirability.
- I.8I: Narrative describing site signage and image of signage to be installed.

Closeout:

- I.8A: Description of installed standing height desk mechanism and number available to occupants, including specifications or purchasing requirements listed.
- I.8B: Description of workstation seating, including specifications or purchasing requirements listed.
- I.8C: Final site or building plan indicating location(s) for nonmotorized vehicle parking.
- I.8D: Final building plan indicating stair location, narrative description of measures implemented to improve visibility and desirability.
- I.8I: Narrative describing site signage.

Additional Resources

Creating Walkable and Bikeable Communities. US Department of Housing and Urban Development: https://www.huduser.gov/portal/sites/default/files/pdf/Creating-Walkable-Bikeable-Communities.pdf.

University at Texas at Austin Physical Specifications for Lactation/Quiet Rooms: https://hr.utexas.edu/sites/hr.utexas.edu/files/LQR_PhysicalRoomSpecs.pdf.

Walk Score: https://www.walkscore.com/cities-and-neighborhoods/.

Guideline I.9 Wayfinding and Universal Access

Intent

To ensure that buildings can be used by all regular occupants, visitors, and other users regardless of age, gender, culture, or ability level. Wayfinding enhances users' experience with the building and facilitates movement to and within it, thereby reducing stress and supporting safety and security. This guideline supports the social and equitable aspects of sustainable design that ensure all people have access to high quality and high performance projects.

Required Performance Criteria

Guidelines apply to all New Construction projects and for Major Renovations that include relevant project scope.

A. Exterior wayfinding:

1. Provide signage (including verbal and pictorial communication) to identify parking areas (including for human powered vehicles), buildings, and entrances.
2. Provide signage to clearly delineate accessible parking and access routes.
3. Provide lighting on exterior including sign elements.

B. Interior wayfinding: For projects with public access or for which the program includes regular visitors to the site:[24]

1. Establish clear routes to common destinations, particularly destinations sought by visitors to the building.
2. Identify all destinations using consistent language, color, or other cues.
3. Use symbols and icons to bridge language barriers.
4. Provide clear, concise, and consistent signs that have strong contrast and visibility.
5. Provide adequate lighting for interior signs.
6. Provide signs at decision points (places in which the navigator must make a decision such as whether to continue straight or turn).
7. Identify spaces, groups of spaces, linking, and organization of spaces, and communicate with building users.

[24] Adapted from *International Health Facility Guidelines,* Part W, "Wayfinding." 2017.

C. Universal Design Principles: Implement at least three of the following in the design and operation of the project:[25]

1. Equitable use: Ensure the building and site are useful and marketable to people with diverse abilities.
2. Flexibility in use: Ensure the building and site accommodate a wide range of individual preferences and abilities.
3. Simple and intuitive use: Ensure the use of the building and site is easy to understand, regardless of user's experience, knowledge, language skills, or current concentration level.
4. Perceptible information: Ensure the building and site communicate necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
5. Tolerance for error: Ensure the building and site minimize the hazards and the adverse consequences of accidental or unintended actions.
6. Low physical effort: Ensure the building and site can be used efficiently and comfortably and with a minimum of fatigue.
7. Size and space for approach and use: Ensure appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

D. Provide at least one dedicated, reservable, lockable, private room that is accessible to all regular building occupants for lactation or other quiet use. The lactation room must include:[26]

1. A comfortable chair with an accessible outlet.
2. A sink.
3. Counter space, waste receptacle, and hand cleaning supplies.

Meeting the Guidelines

During Predesign and concept development, work with owner to establish wayfinding needs and strategy. Identify user groups who may rely on wayfinding when visiting or occupying the building. Develop and document a wayfinding strategy that works within project scope, budget, and design intent and can be applied consistently across the project.

Work with owner to establish universal design goals and select universal design principles that will be addressed in the project. Review strategies (see Additional Resources) that contribute to universal and inclusive design and select approaches that work within project scope, budget, and design intent.

During schematic design, document and describe strategies employed in project for at least three universal design principles. Document wayfinding strategy and implementation including design and placement of signage and other wayfinding cues.

Work with owner to determine number of and characteristics of lactation/quiet room(s). These spaces should be easily accessible and adaptable, and pleasant to use.

If post-occupancy evaluations are conducted, address issues that arise regarding wayfinding and universal access.

[25] Adapted from *Inclusive Design in the Built Environment,* Sandra Manley. 2016

[26] This guideline is aligned with credits available under the Fitwel Certification Program.

Submittal Requirements

Design:

- I.9A: Preliminary site plan indicating signage location for all parking areas, building entrances, handicap parking and access routes.
- I.9B: Preliminary description of wayfinding strategies and execution.
- I.9C: Preliminary description outlining intended project compliance method and identification of at least three criteria project is expected to meet.
- I.9D: Preliminary building plan indicating location of LQR meeting guideline requirements.

Final Design:

- I.9A: Final site plan indicating signage location for all parking areas, building entrances, accessible parking, and access routes. Provide images of project signage and electrical plan for providing lighting as necessary.
- I.9B: Final description of wayfinding strategies and execution, including annotated floor plan indicating location of implemented strategies.
- I.9C: Description outlining project compliance method and identification of at least three criteria included in project design.
- I.9D: Final building plan indicating location of lactation rooms meeting guideline requirements.

Additional Resources

AIA Best Practices for Lactation Room Design:
https://www.aia.org/best-practices/17116-recommendations-for-designing-lactationwelln.

Design Resources: DR-01 Architectural Wayfinding. Center for Inclusive Design and Environmental Access, University of Buffalo School of Architecture and Planning:
https://udeworld.com/documents/designresources/pdfs/ArchitecturalWayfinding.pdf.

Health Facility Guidelines, Part W, “Wayfinding Design Principles”:
http://healthfacilityguidelines.com/Guidelines/ViewPDF/iHFG/iHFG_part_w_wayfinding_design_principles.

Inclusive Design in the Built Environment. Design Commission for Wales: https://s3-eu-west-1.amazonaws.com/dcfw-cdn/InclusiveDesign_traininghandbook.pdf.

Inclusive Design Standards. London Legacy Development Corporation:
http://www.queenelizabetholympicpark.co.uk/~/media/qeop/files/public/inclusivedesignstandardsmarch2013.pdf.

Wayfinding Design Guidelines, Cooperative Research Centre for Construction Information:
http://www.hpw.qld.gov.au/sitecollectiondocuments/wayfindingdesignguidelines.pdf.

Site and Water Guidelines

Intent

To support the design and maintenance of project sites which restore the ecological integrity of the site by restoring the local soil and water quality capable of supporting healthy, biodiverse plant, animal, and human communities. Current development practices on the land can lead to damaging stormwater runoff, degraded water and soil quality, depletion of water, soil, and valuable vegetated areas, and destruction of habitat. These sites are anticipated to reduce water and energy consumption; improve the rate, quantity, and quality of stormwater runoff; and minimize pollutant contributions related to transportation requirements.

Objectives:

- To improve the ability of the soil to maintain its biotic and abiotic structure against adverse impacts of development.
- To restore the site's hydrologic cycle in order to improve the soil, vegetative and animal habitats, and to mitigate adverse onsite and downstream water impacts.
- To reduce consumption of potable water and fossil energy with appropriate site design and the use of local vegetative materials.
- To reduce the amounts of toxic materials and salts used on project sites that contribute to air and water pollution.
- To enhance the biodiversity of the site and surrounding networks of flora and fauna.
- To ensure that local native and endangered species have habitats.
- To restore/improve the outdoor environmental quality (OEQ) of the site to enhance occupant productivity, building performance, and community benefits.

General Site and Water Information:

The following information is collected in the Site and Water Section of the B3 Guidelines Tracking Tool, Section S.0:

Predesign:

- Site information: existing site areas of various conditions (e.g., wetland, building footprint, woodland).

Design:

- Updated site information: existing and proposed site areas of various conditions (e.g., wetland, building footprint, woodland).

Final Design:

- Updated site information: existing and proposed site areas of various conditions (e.g., wetland, building footprint, woodland).
- Site and water strategies used, including narrative.

Closeout:

- Updated site information: existing and proposed site areas of various conditions (e.g., wetland, building footprint, woodland).
- Updated site and water strategies used, including narrative.

Definition of Project Site

Defining the project site can be accomplished in the following methods:

1. Use property lines to determine the project site.
2. Include at least the area disturbed as a result of the construction activities of the project if the project is part of a larger campus. This disturbed area will be considered the primary project site.

On sites using the second method more flexible site considerations can be used in meeting the site and water requirements. Projects may meet the requirements of the primary project site by interventions on the larger campus outside of the primary site area (including in areas that is separated by a public right-of-way). The area used to meet the B3 Guidelines will be considered a secondary project site (or sites) and must be owned by the same entity as the primary project site. Different secondary project sites may be defined as necessary to meet different guidelines.

These interventions on secondary project sites must satisfy the requirements for the primary project site area and consist of a modification performed as part of the project and documented as a permanent modification. A modification of a secondary project site is not required for existing animal habitats that meet the B3 habitat requirements and that are immediately adjacent to the primary project area. The secondary site area may not contribute to meeting the B3 Requirements if it is also used to satisfy other preexisting or planned regulatory requirements. The secondary site area, if it is used to satisfy any regulatory requirement for any area outside of the primary project site (e.g., the portion of a secondary site area which contributes to meeting stormwater runoff requirements for an area outside of the primary project site), cannot be considered to contribute to B3 compliance.

Interventions may include but are not limited to regional stormwater management, pollinator locations, animal habitat, or local vegetation; each can each be located on a portion of the campus that would be best suited for such a use. In most cases, larger ecological areas and district stormwater systems are preferable to scattered smaller systems.

Guideline S.1: Site and Water Connections

Intent

To create sites that are resilient, healthy and sustainable, ensure connections between the surrounding environment and the site through vegetation selection, animal habitats, and connections to human-made systems.

Required Performance Criteria

Guidelines apply to all projects designated New Buildings and Major Renovations with site work site scope that includes an area of site disturbance that is greater than 3,000 s.f. OR Area of imperviousness (footprint of building plus site impervious area) renovated that is greater than 2,000 s.f

A. Plant network connections: Establish plant selection to reinforce existing plant networks and to support and expand existing conservation, and natural and native species networks.
    1. The greater of either 25% of the project site area (excluding the building footprint), or 70% of the project site area (excluding the building footprint and code-minimum parking) should be planted using native species listed in the class factsheet for the applicable class.
        i. Native is defined as a plant originating from within a 200-mile radius of the site prior to human intervention, considered to be 1840 in Minnesota. Cultivars (CVs) of native species may be used if they do not appear on the Minnesota Native Plant Society or Minnesota Invasive Terrestrial Plants and Pests Center Prioritized list of terrestrial invasive plants, or on the Minnesota Department of Agriculture Noxious Weeds list.
        ii. Ecological class shall be determined from the province, section, and subsection of the site listed under the Minnesota Department of Natural Resources (DNR) Ecological Classification System (ECS).
        iii. The most advantageous plant species prevalent in the listed ecological class of the site shall be determined for use in revegetation.
    2. If the project site is within 10 miles of a DNR Scientific and Natural Area (SNA), plant selection shall be used to match, connect, and reinforce the conservation area.
    3. If the project site is within 1 mile of an SNA as defined by the DNR, vegetative and plant selections shall be used to connect, reinforce, and replicate the natural area.

Note: Other vegetation requirements are also listed under S.4: Vegetation.

B. Animal network connections: Include in the project design appropriate habitats, including both food and shelter, of relevant species if the following criteria are met:
    1. If project is within 10 miles of major bird migratory flyways, nesting habitat, or stopover feeding areas.
    2. If project site is within 1 mile of an existing or planned animal movement corridor.
    3. If project site is within 10 miles of a Wildlife Management Area.
    4. If project site is within 1 mile of the terrestrial habitats of rare, threatened, or endangered reptiles / amphibians of Minnesota.
    5. If project site is within 1 mile of the habitats of rare, threatened, or endangered insects / arthropods of Minnesota.
    6. If project site is adjacent to the aquatic habitat of rare, threatened, or endangered fish of Minnesota.
    7. If project site is within 1 mile of known important bird habitats and nesting areas of rare, threatened, or endangered birds of Minnesota.
    8. If project site is within 10 miles of a National Wildlife Refuge or National Wetland Management District.

Note: Other animal habitat requirements are listed under S.5: Light Pollution Reduction.

C. Human system connections: The project design should include appropriate connections to any of the relevant systems in response to the following criteria:
   1. If project is within 1 mile of an existing or planned bike path, local government officials should be consulted to assist in the creation of bike connections between site and existing routes.
   2. If project is within 1 mile of an existing or planned walking path, local governmental officials should be consulted to assist in the creation of a safe walking connection between site and existing routes.
   3. If project is within 1 mile of an existing or planned future DNR water trail, local governmental officials should be consulted to assist in the creation of a connection to existing or future water trails.
   4. If project is within 1 mile of an existing or planned birding trail, county and governmental officials should be consulted to assist in the creation of a connection to existing or future planned DNR or MN Audubon birding trails.
   5. If the project is within 0.25 miles of an existing or planned transit stop, local transit officials should be consulted to assist in the creation of a pedestrian path and waiting shelter at the stop (if none exist).

   Systems can be considered planned if they are in a community master plan, small area plan, comprehensive plan, or 5-year capital budget.

Recommended Guidelines

D. Project site plans should be coordinated with municipal, regional, county, and state planning agencies.
E. Historical context: Available historical context should be incorporated into the design of the project site:
   1. Historical land survey or historical maps.
   2. Landview and/or historical photos, including historical aerial photos.
   3. Historical topography.

Meeting the Guidelines

For vegetation-specific requirements, the determination of the ECS is made by referencing the DNR Ecological Classification System maps: http://www.dnr.state.mn.us/ecs/index.html. Accessing the site allows the provinces, sections, and subsections to be determined. The following resource is available to make vegetative connection determinations for conservation and natural areas: http://www.dnr.state.mn.us/snas/map.html. The plant community of a project site can be determined through the DNR Native Plant Community Classification, located at http://www.dnr.state.mn.us/npc/classification.html. Class fact sheets that include allowable plant selections are located at the following locations:

- Upland Forests and Woodlands: http://www.dnr.state.mn.us/npc/uplandforest.html.
- Wetland Forests: http://www.dnr.state.mn.us/npc/wetforest.html.
- Upland Grasslands, Shrublands, and Sparse Vegetation: http://www.dnr.state.mn.us/npc/uplandgrassland.html.
- Wetland Grasslands, Shrublands, and Marshes http://www.dnr.state.mn.us/npc/wetlandgrassland.html.

For determining the location of existing or planned animal corridors, the project site should be located in reference to the following resources to determine:

- Wildlife Action Network Maps: http://www.dnr.state.mn.us/mnwap/mnwap_resources.html.
- Statewide Map of the Wildlife Action Network with County Boundaries: http://files.dnr.state.mn.us/assistance/nrplanning/bigpicture/mnwap/mndnr_wildlife_action_network_county.pdf.
- Prairie Corridors: https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/minnesota/mn-prairie-conservation-plan-part-ii.pdf.

- Metropolitan Conservation Corridors: http://www.dnr.state.mn.us/metroconservationcorridors/index.html.
- Regionally Significant Natural Resource Areas: http://www.dnr.state.mn.us/rsea/map.html.
- Mammals of Minnesota: http://www.dnr.state.mn.us/mammals/index.html.
- Floodplain Forest Management along Vermillion and Cannon Rivers: http://www.dnr.state.mn.us/nrplanning/bigpicture/vermillion/index.html.

Major migratory flyways, nesting habitat, and stopover feeding areas can be located through the following resources. The site location should be checked against at least the following:

- Birds of Minnesota: http://www.dnr.state.mn.us/birds/index.html.
- Important Bird Areas in Minnesota: http://mn.audubon.org/conservation/minnesota-important-bird-areas.
- Bird Trails:
    - Northshore Birding Trail: http://audubon.maps.arcgis.com/apps/MapTour/index.html?appid=016293823ced4b7f9cb79389ecdd5a3c&webmap=0f48989d6fdd4584b8528628710a7846.
    - Minnesota River Valley Birding Trail: http://gis.audubon.org/Minnesota/MRVT/#.
    - Pine to Prairie Birding Trail: https://mnbirdtrail.com/
    - The Great River Birding Trail: http://gis.audubon.org/Minnesota/birdtrails/#.
    - St. Cloud, MN map, from Little Falls, MN to Anoka, MN (River Mile 970 to 870): http://experiencemississippiriver.com/10states/wp-content/uploads/2016/04/Binder4.pdf.
    - Minneapolis and St. Paul, MN map (River Mile 870 to 823): http://experiencemississippiriver.com/10states/wp-content/uploads/2016/04/Binder5.pdf.
    - Red Wing, MN map, from Cottage Grove, MN to Kellogg, MN (River Mile 823 to 755): http://experiencemississippiriver.com/10states/wp-content/uploads/2016/04/Binder6.pdf.
    - La Crosse, WI map, from Kellogg, MN to New Albin, IA (River Mile 755 to 674): http://experiencemississippiriver.com/10states/wp-content/uploads/2016/04/Binder7.pdf.

Animal connections can be determined by referencing the following:

- Wildlife Management Areas: http://www.dnr.state.mn.us/wmas/index.html.
- Terrestrial Habitats of Reptiles / Amphibians of Minnesota: http://www.dnr.state.mn.us/reptiles_amphibians/index.html.
- Habitats of the Mammals of Minnesota: http://www.dnr.state.mn.us/mammals/index.html.
- Habitats of the Fish of Minnesota: http://www.dnr.state.mn.us/fish/index.html.
- Habitats of the Mussels of Minnesota: http://www.dnr.state.mn.us/mussels/index.html.
- Habitats of the Insects / Arthropods of Minnesota: http://www.dnr.state.mn.us/insects/index.html.
- Known Important Bird Habitats and Nesting Areas for the Birds of Minnesota: http://www.dnr.state.mn.us/birds/index.html.
- National Wildlife Refuge or National Wetland Management District: https://www.fws.gov/refuges/refugeLocatorMaps/Minnesota.html.

Human systems connections can be determined by referencing the following:

- US or Minnesota State Highways: http://www.dot.state.mn.us/statemap/2017/map-front.pdf.
- Mass Transit Routes: http://www.dot.state.mn.us/transit/riders/.
- Existing Bicycle Trails: http://www.dot.state.mn.us/bike/maps/2017-state-bike-map.pdf.
- Walking and Hiking Trails and Routes: https://www.traillink.com/stateactivity/mn-walking-trails/ and http://www.dnr.state.mn.us/state_trails/index.html.

- Water Trails, under Minnesota State Water Trails: http://www.dnr.state.mn.us/watertrails/index.html and http://www.dnr.state.mn.us/watertrails/az.html.
- Minnesota Birding Trails and Maps: https://www.traillink.com/stateactivity/mn-birding-trails/.

Ensure that all new impervious areas included as part of the human systems connections are included in infiltration calculations for Guideline S.2.

Historical resources available for reference include:

- Historic Topography: http://www.lib.utexas.edu/maps/topo/minnesota/, http://libguides.mnhs.org/maps/topographic and https://nationalmap.gov/historical/.
- Original General Land Office Plats: http://www.mngeo.state.mn.us/glo/index.html.
- The DNR Landview: http://www.dnr.state.mn.us/maps/landview/index.html?layers=lakes+roads+cent_popplpt1 includes information that may supplement other historic site information.
- Minnesota Historical Society Photograph Collection: http://sites.mnhs.org/library/content/photograph-collection.
- Minnesota Historical Aerial Photographs: https://www.lib.umn.edu/apps/mhapo/.

Submittal Requirements

Predesign:

- S.1A: Documentation of the province, section, and subsection of the site, any identified conservation or natural areas within the distance specified in the guidelines, and the designated native plant communities of the site.
- S.1B: Documentation of the determination of animal communities within the listed distances.
- S.1C: Identified roads, transit, trails, and walking paths within the listed distances.

Design:

- S.1A: Narrative on the response to native and conservation areas and a list of relevant species selected for the site from the class factsheet.
- S.1B: Site plan that documents planned animal habitat as required.
- S.1C: Site plan that documents required human network connections.
- S.1E: Site plan demonstrating incorporation of historic site information into design of site.

Final Design:

- S.1A: List of vegetation selected demonstrating compliance, including the class fact sheet; narrative on the project response to native and conservation areas; list of species selected from the class factsheets for site and area of site planted with listed species.
- S.1B: Final site plan documenting animal habitat as required.
- S.1C: Final site plan documenting required human network connections.
- S.1D: Documentation of coordination with municipal, regional, county, and state planning agencies.
- S.1E: Final site plan demonstrating incorporation of historic site information into design of site.

Additional Resources

Ecological System Summaries and Class Fact Sheets – Upland Forests and Woodlands: http://www.dnr.state.mn.us/npc/uplandforest.html; Wetland Forests: http://www.dnr.state.mn.us/npc/wetforest.html; Upland Grasslands, Shrublands, and Sparse Vegetation: http://www.dnr.state.mn.us/npc/uplandgrassland.html; Wetland Grasslands, Shrublands, and Marshes: http://www.dnr.state.mn.us/npc/wetlandgrassland.html.

Eco-Regions for Minnesota: ftp://newftp.epa.gov/EPADataCommons/ORD/Ecoregions/mn/mn_map.pdf, Description of Eco-Regions: ftp://newftp.epa.gov/EPADataCommons/ORD/Ecoregions/mn/mn_eco_desc.pdf.

Ecological Classification System: http://www.dnr.state.mn.us/ecs/index.html.

Floodplain: Elevation Requirements: http://www.dnr.state.mn.us/waters/watermgmt_section/floodplain/rfpe.html.

Flood Plan Maps by County: ftp://ftp.dnr.state.mn.us/pub/waters/floodplain/County_data/.

Gridded Soil Survey Geographic (gSSURGO) Database: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053628.

Minnesota Department of Agriculture Noxious Weeds: https://www.mda.state.mn.us/plants-insects/minnesota-noxious-weed-list, PDF at https://www.mda.state.mn.us/sites/default/files/inline-files/noxiousweeds2018.pdf

Minnesota Association of Watershed Districts, Inc.: http://www.mnwatershed.org/.

Minnesota Scientific and Natural Areas Find by Map: http://www.dnr.state.mn.us/snas/map.html.

Model My Watershed Technical Documentation: https://wikiwatershed.org/documentation/mmw-tech/#layers-viewable-mapped-data.

Minnesota Invasive Terrestrial Plants and Pests Center Prioritized list of terrestrial invasive plants: http://www.mitppc.umn.edu/

NOAA Atlas 14-Point Precipitation Frequency Estimates: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=mn.

Natural Features of Minnesota: http://www.dnr.state.mn.us/maps/compass.html.

Nongame Wildlife – South Region: http://www.dnr.state.mn.us/eco/nongame/south.html.

Nongame Wildlife – Northwest Region: http://www.dnr.state.mn.us/eco/nongame/nw.html.

Nongame Wildlife – Northeast Region: http://www.dnr.state.mn.us/eco/nongame/ne.html.

Nongame Wildlife – Central Region: http://www.dnr.state.mn.us/eco/nongame/central.html.

Soil Hydrology of the United States: http://resources.arcgis.com/en/communities/soils/02ms00000008000000.htm.

Glossary

Food:

Food should be of quality and quantity that would be normally found in the area that is created with natural food-bearing trees and bushes.

Guideline S.2: Site Water Quality and Efficiency

Intent

To restore the natural water cycle of Minnesota biomes in order to support natural hydrology, soils, vegetation and animals, reduce and limit the amount of chemicals and soil leaving the site, reduce the potable water usage, and to respond to the ecological factors of the project site within the larger watershed.

Required Performance Criteria

Guidelines other than S.2D apply to all projects designated New Buildings and Major Renovations with site work site scope that includes an area of site disturbance that is greater than 3,000 s.f. OR Area of imperviousness (footprint of building plus site impervious area) renovated that is greater than 2,000 s.f..

Guideline S.2D applies for all projects which include renovation or replacement of plumbing fixtures. Major Renovation projects must faucets and showerhead in the renovated area shall be upgraded with low-flow products. Major Renovation projects may otherwise limit performance criteria application to the number of fixtures included in the renovation scope.

A. Stormwater quantity and watershed connections. Water leaving the project site is subject to the following:
   1. Site water cycle requirements: The project site shall manage stormwater to meet the required percentage of site infiltration, evapotranspiration, and runoff according to its soil types, as evaluated using the Minnesota Impact Design Standard (MIDS) calculator and based on an annual evaluation. Additional requirements for A and B soils located in the uplands and lowlands of the watershed are listed under Part 2 below:

Hydrological Soil Groups	**Infiltration at Least**	**Evapotranspiration at Least**	**Onsite Reuse**	**Runoff Not to Exceed**	***Total Onsite Managed***
A Soils: 1.63–0.8 in./hr.	100%	0%	0%	0%	*100%*
B Soils: 0.45–0.3 in./hr.	50%	40%	5%	5%	*95%*
C Soils: 0.2 in./hr.	30%	55%	7%	8%	*92%*
D Soils: 0.006 in./hr.	0%	60%	25%	10%	*85%*

Subject to the following:

i. Infiltration rates based on onsite testing shall be used.
ii. Additional infiltration above the percentage required may be used to meet evapotranspiration and onsite reuse requirements.
iii. Additional evapotranspiration may be used to meet onsite reuse requirements.
iv. Infiltration rates and location shall be subject to both water table vulnerability (https://gisdata.mn.gov/dataset/water-aquifer-vulnerability) and ground water contamination susceptibility (https://www.dnr.state.mn.us/whaf/about/scores/geomorphology/gw_contamination.html.)
v. Sites or areas of sites prohibited from infiltration per the NPDES Permit Application Requirements are permitted to satisfy the total onsite managed requirements using other listed means.

Onsite roof-collected rainwater may be used to offset infiltration requirements at a rate of 1 to 1, subject to the guidance below:

vi. Roof-collected rainwater can be employed without treatment when first-flush technology is utilized. Ensure compliance with local plumbing codes.
vii. Roof-collected rainwater shall be prioritized to supplement the site's water holding requirements and used for one of the onsite designated uses in the following order (some of these may require additional purification). Ensure compliance with local plumbing codes.
    (1) For animal habitat per S.1 and S.5: Water should be held in locations to which site animals can have continual water access.
    (2) For subsurface irrigation of the site planting.
    (3) For evaporative cooling on flat roofs (roof-collected rainwater only, from "blue roofs").
    (4) For cooling towers (roof-collected rainwater only).
    (5) For nonpotable water usage (depending on use may be rainwater only).
    (6) For toilet flushing (roof-collected rainwater cleaned to a potable standard).

2. Watershed connections: (Note that if the project is within a watershed district or management organization's jurisdiction there may be other requirements for the site not listed here).
    i. For projects located in the uplands of the watershed and in Hydrologic Soil Group A: High Infiltration or in Hydrologic Soil Group B: Moderate Infiltration, infiltration of all rainfall events should be planned for a 25-year, 24-hour rain event for project area.
    ii. For projects located in the lowlands and Hydrologic Soil Group A: High Infiltration or in Hydrologic Soil Group B: Moderate Infiltration, infiltration of all rainfall events should be planned for a 10-year, 24-hour rain event for project area.
    iii. The features of the site's location in the watershed or lakeshed, and any site-watershed features should be used to inform the design of the site.
3. Flood prevention: If required by building program to construct within a flood plain, the project shall follow the Federal Emergency Management Agency's (FEMA) regulatory flood protection elevation requirements. Building in a floodplain is prohibited unless essential to the program of the project.
4. Runoff rate: The site shall be designed to not exceed the pre-settlement runoff rate for native soil and vegetation conditions, as evaluated by achieving compliant curve numbers (CN) per Natural Resources Conversation Service (NRCS) TR-55 below those of the pre-settlement condition.

B. Stormwater quality:
1. Provide treatment systems designed to remove 80% of the post-development Total Suspended Solids (TSS) and 60% of the post-development Total Phosphorus (TP). The design of the retention of TSS and TP shall be accomplished with best management practices and calculated using the MIDS calculator.
2. The reduction of chlorides shall be accomplished by:
    i. Reducing the area of ongrade impervious surfaces requiring chlorides by 20%.
    ii. Reducing the amount of chlorides on the remaining impervious surfaces by employing the Minnesota Pollution Control Agency (MPCA) Winter Maintenance Assessment tool as operational practice.
    iii. Developing a chloride management plan for site operations to ensure ongoing chloride-use limits.
    iv. Inclusion of planning of alternative measures to de-ice (e.g. utilization of sand, incorporation of snow-melt systems).

C. No potable water shall be used for irrigation after a 5-year plant establishment period except for periods when actual rainfall for the month is less than 30% of the average rainfall for that month. Collected roof rainwater and graywater may be used for plant irrigation at any time. Turf grass integral to the program of the site, such as athletic fields or school recreational fields are excluded from the calculation for this requirement.

D. Municipal potable water or harvested groundwater use in building shall be reduced by 50% compared to a baseline established on the 1992 Energy Policy Act requirements and including water-consuming appliances for all uses associated with fixture types referenced by those requirements. The criteria may be met by any combination of the following: selection of low or no-flow fixtures, use of recycled rainwater, or other strategies.
    1. Renovation portions of projects may limit performance criteria application to the number of fixtures included in the renovation scope subject to the following exemption:
        i. Faucets in the renovated area shall be upgraded with low-flow faucet aerators, and showerheads shall be upgraded with low-flow showerheads even if other plumbing fixtures are not upgraded.
    2. Recycled rainwater can also be used to offset the percentage of potable water usage, if allowed in the local jurisdiction.
    3. To verify compliance with this guideline during operation of building, it is necessary to submeter indoor water consumption separately from irrigation.

Recommended Performance Criteria

E. No potable water shall be used for irrigation after a two-year plant establishment period except for periods when actual monthly rainfall is less than 30% of the average rainfall for that month. Graywater may be used for plant irrigation.

F. Municipal potable water or harvested groundwater use in building shall be reduced by 70% compared to code (1992 Energy Policy Act requirements) for all uses associated with fixture types referenced by those requirements. The criteria may be met by any combination of the following: selection of low or no-flow fixtures, use of alternatively sourced water, or other strategies. Major Renovation Path projects may limit performance criteria application to the number of fixtures included in the renovation scope.

Meeting the Guidelines

Employ the Minnesota's Minimal Impact Design Standard calculator at https://stormwater.pca.state.mn.us/index.php/MIDS_calculator to design the best management practices (BMPs) for the project site to meet the amount of rainwater required to infiltrate project site, amount of rainwater required to evapotranspirate on project site, and amount of rainwater allowed to run off project site.

Storm events are listed under NOAA ATLAS 14: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=mn.

Use the Soil Survey Geographic Data Base (SSURGO), Minnesota at https://gisdata.mn.gov/dataset/geos-ssurgo to determine the hydrological soil group(s) for project site. Employ the MIDS calculator located at https://stormwater.pca.state.mn.us/index.php/MIDS_calculator to design a site that meets the rainwater retention requirements with BMPs.

Water network connections can be determined by using the following resources:

- Watershed and lakeshed location:
    - Hydrologic units (HU) level 6: sub-watersheds (10,000-40,000 acres), minor watershed (3,000 acres) or HU (100 acres) DNR catchments level 09 are listed here: http://www.dnr.state.mn.us/watersheds/map.html

    - More detail is available under the following:
        - www.dnr.state.mn.us/watersheds/lakeshed_project.html
        - http://www.mngeo.state.mn.us/chouse/water_watersheds.html
        - https://streamstats.usgs.gov/ss/
        - http://www.dnr.state.mn.us/watersheds/lakeshed_project.html
        - https://www.dnr.state.mn.us/whaf/about/scores/geomorphology/gw_contamination.html
        - https://gisdata.mn.gov/dataset/water-aquifer-vulnerability
- The US EPA Surf Your Watershed program provides detailed information on watersheds: https://cfpub.epa.gov/surf/state.cfm?statepostal=MN.
- Watershed Management Districts and Watershed Management Organizations of Minnesota: https://www.mnwatershed.org/where-is-my-wa/ and http://www.bwsr.state.mn.us/maps/Website/Land%20&%20Water/Water%20Management/Metro_WDWMO_Plan_Revisions.pdf.

Note: If the project is in a designated area, contact the organization for other specific requirements for the site.

Soil hydrology is determined using the Soil Hydrology of the United States page: http://resources.arcgis.com/en/communities/soils/02ms00000008000000.htm. Determine which of the following drain classes are contained on the site:

1. Excessively Drained
2. Somewhat Excessively Drained
3. Well Drained
4. Moderately Well Drained
5. Somewhat Poorly Drained
6. Poorly Drained
7. Very Poorly Drained

Based on the drainage designation at ATLAS 14 rainfall estimates (available at https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html).

The site's flood plain designation should be based on FEMA mapping (listed using FEMA'a National Flood Hazard Layer viewer at http://fema.maps.arcgis.com/home/webmap/viewer.html?webmap=cbe088e7c8704464aa0fc34eb99e7f30), which includes the following designations:

1. 1% Annual Chance Flood Hazard (under consideration)
2. Regulatory Floodway
3. Special Floodway
4. Area of Undetermined Flood Hazard
5. 0.2% Annual Chance Flood Hazard
6. Future Conditions 1% Annual Chance Flood Hazard
7. Area with Reduced Risk Due to Levee

If the site is designated as any of the previous categories, contact the county flood plan maps by county at ftp://ftp.dnr.state.mn.us/pub/waters/floodplain/County_data/ to verify FEMA designation. Any sites or portion of sites in designated floodplain areas should not include building construction unless it is essential to the building program. If a building is necessary, it must meet the regulatory flood protection elevation, as listed at http://www.dnr.state.mn.us/waters/watermgmt_section/floodplain/rfpe.html.

Perform soil infiltration test(s) on project site using methods listed in the Minnesota Stormwater Manual, determining soil infiltration rates located at https://stormwater.pca.state.mn.us/index.php?title=Determining_soil_infiltration_rates. Use the infiltration test(s) to compare with the infiltration rates of the hydrological soil group(s) located at https://stormwater.pca.state.mn.us/index.php?title=Design_infiltration_rates. Use the more restrictive infiltration estimate for project site design.

The onsite retention of TSS, phosphorus, and nitrogen can be calculated by applying the selected design strategies via the MIDS calculator and reporting results.

A 20% reduction in the impervious areas that need chlorides may be accomplished through design; the remainder may be removed by the following strategies:[27]

- Hire a Smart Salting Certified contractor, Levels 1 and 2: https://www.pca.state.mn.us/water/salt-application-training.
- Track and document annual salt use in total pounds and square footage of applied areas.
- Develop and follow a snow and ice policy: https://www.pca.state.mn.us/sites/default/files/p-tr1-51c.pdf.
- Utilize the Winter Maintenance Assessment tool (WMAt) to track and improve BMPs. Within three years, all BMPs shall reflect the highest level of management: https://stormwater.pca.state.mn.us/index.php/Winter_Maintenance_Assessment_tool_(WMAt).
- Follow the salt application rate guidelines in the MPCA's Winter Parking Lot and Sidewalk Maintenance Manual: https://www.pca.state.mn.us/sites/default/files/p-tr1-10.pdf.
- Use liquid deicers where and when possible.
- Create regular assessments in the WMAt with 10% or less poor practices (red).
- Educate/inform employees and guests of the building about Smart Salting.
- Implement: Achieve 100% green of total practices in the MPCA Winter Maintenance Assessment tool within five years of building occupancy.

A chloride management plan with the goal of creating a chloride-free site in ten years (https://stormwater.pca.state.mn.us/index.php?title=Chloride_Management_Plan) may include the following:

a. Use of sand substitution (from first-year occupancy).
b. Use of alternate salts such as magnesium chloride (after two years of occupancy).
c. Use of substitute alternatives to reduce chloride, such as beet juice (after four years of occupancy).

The irrigation water use shall be metered and recorded for at least five years after building occupancy or until site planting is fully established. No potable water shall be used for outdoor use such as sidewalks, driveways, or vehicle washings. In addition, no potable water shall be used to irrigate or water after five years of plant establishment except during periods of drought. During periods of drought, potable water irrigation and watering is permitted to ensure plant survival. It is recommended that 90% of plant materials are drought tolerant and that decorative plants only require irrigation for non-severe droughts. Periods of severe drought are defined as months in which monthly rainfall is 70% less than average. Captured rainfall can be used anytime for irrigation and watering of plant materials.

Worksheet S-2 Building Water Calculator should be used to calculate building water use for base and design. This also calculates the base-case condition for Energy Policy Act required flow and flush fixture rates, and provides example fixture performance values for uses associated with those fixtures. Annual water consumption must be submitted to the B3 Guidelines Tracking Tool for a period of ten years after building occupancy through the B3 Benchmarking program.

[27] MPCA – Chloride reduction strategies

The proposed graywater treatment system shall meet the environmentally feasible, acceptable soil infiltration condition, and the onsite graywater wetland treatment system or the manufactured graywater treatment system shall be cost effective. The volume of graywater and the required size of the graywater treatment train or manufactured systems shall meet the NSF/ANSI 350 and 350-1, Onsite Water Reuse Treatment Systems standards for the intended final use. If blackwater onsite water treatment is pursued, then a qualified professional should be employed to meet the NSF/ANSI 350 and 350-1, Onsite Water Reuse Treatment Systems standards. Treated blackwater shall not be reused but can be used to supplement a site's infiltration requirements if the treated blackwater is infiltrated through underground drainage fields.

The watershed on which the project site is located can be found using the website https://app.wikiwatershed.org/ and selecting US Geological Survey (USGS) Subwatershed Unit (HUC-12) for the selected boundary, then selecting the "free draw" area, and then selecting the Continental US Medium Resolution for Delineate Watershed. Under the Layers subheading: For streams, select Continental US Medium Resolution Stream Network; for coverage grid, select Hydrologic Soil Groups from gSSURGO; for boundary, select USGS Subwatershed Unit (HUD-12); for observation, select EPA Permitted Point Sources; for base map, select Terrain. If the project site has soils in Hydrologic Soil Group A: High Infiltration or Hydrologic Soil Group B: Moderate Infiltration, plans should include at least 10% higher infiltration of all rainfall events.

Submittal Requirements

Predesign:

- S.2E: Submit a map of the watershed with the project site located within the watershed boundaries.

Design:

- S.2A: Submit the requirements for infiltration, evapotranspiration, and runoff derived from referencing the ATLAS-14 storm events. Submit the site percolation test(s) for the project site. If pursuing graywater treatment, submit preliminary site plan delineating the placement of the graywater treatment system on the site and the preliminary sizing of the treatment wetland. Provide the identification of watershed or lakeshed of the project, drainage class(es) of the site, watershed organization jurisdiction, and identified watershed location if Soil Groups A or B is present, including planned rainfall infiltration if site soils include Soil Group A or B and are in the uplands or lowlands of watershed. Note the flood plain designation of the site. Submit completed Excel document demonstrating compliance with infiltration and other on-site managed criteria. Provide additional calculations as necessary to document evapotranspiration contribution to meeting guideline criteria.S.2B: Upload the completed MIDS Excel document demonstrating intended removal systems for required TSS and phosphorus reductions.
- S.2D (and S.2G, if pursuing): Submit base and design case indoor water consumption, any alternatively sourced indoor water used, updated completed Building Water Calculator documenting required reduction from base case, and verification that site contractor understands the requirements and intents of this guideline.
- S.2E: Submit map of the watershed with the project site located within the watershed boundaries with slopes (percent of each gradation on site 0%, 1%, 2%, etc.), hydrological classification of the soils by gSSURGO legends (percent of each soil type, A, B, C, etc.). Submit a site plan with identified micro-catchments or buffers, if required per guideline.

Final Design:

- S.2A: Provide documentation of final project site design demonstrating conformance with the project site requirements concerning infiltration, evapotranspiration, and runoff. List of significant watershed features

incorporated into the final project site design, and indication of compliance with additional rainfall infiltration if site soils include Soil Group A or B and are in the uplands or lowlands of watershed.
- S.2B: Upload the completed MIDS Excel document documenting design's removal systems for required TSS and phosphorus reductions. Provide narrative of chloride reduction methods.
- S.2C (and S.2F if pursued): Submit verification that all plant materials are either drought tolerant or can live without potable water after plant establishment period.
- S.2D (and S.2G if pursuing): Submit updated base and design case indoor water consumption, any alternatively sourced indoor water used, and updated completed Building Water Calculator documenting required reduction from base case.

Closeout:

- S.2B: Submit the Watershed Organization Inspection Report on the stormwater system's installation.
- S.2D (and S.2G if pursuing): Provide updated base and design case indoor water consumption, any alternatively sourced indoor water used, updated completed Building Water Calculator documenting required reduction from base case, and verification that site contractor understands the requirements and intents of this guideline.

Occupancy – Submitted annually for ten years:

- S.2A: As required by the installation manual, document any required inspection and monitoring at prescribed intervals the onsite graywater wetland treatment system or the manufactured graywater treatment system to ensure proper functioning and water quality safety.
- S.2B: Conduct annual inspection of stormwater infrastructure and BMPs to ensure proper functioning. This inspection could be coordinated with the expertise and resources of the local watershed district. Submit bi-year inspection report on BMPs structures. For the first, second, fourth, seventh, and tenth year, submit chloride management plan reports on incremental elimination of chloride loading onsite.
- S.2C: Submit confirmation after the sixth year that all planting materials are.
- S.2D: Report on potable or harvested groundwater indoor water consumption.

Additional Resources

Model My Watershed Technical Documentation: https://wikiwatershed.org/documentation/mmw-tech/#layers-viewable-mapped-data.

Description of Gridded Soil Survey Geographic (gSSURGO) Database: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053628.

Soil Hydrology of the United States: http://resources.arcgis.com/en/communities/soils/02ms00000008000000.htm.

Web Soil Survey (WSS): https://websoilsurvey.nrcs.usda.gov/app/.

Minnesota Soil Survey Status by County: https://stormwater.pca.state.mn.us/index.php?title=File:Minnesota_soil_survey_status.png.

Natural Vegetation of Minnesota at the Time of the Public Land Survey 1847–1907: http://files.dnr.state.mn.us/eco/mcbs/natural_vegetation_of_mn.pdf or http://www.mngeo.state.mn.us/chouse/land_use_historic.html or https://gisdata.mn.gov/dataset/biota-marschner-presettle-veg

Marschner Maps: http://discussions.mnhs.org/collections/wp-content/uploads/2008/09/092_marschner.jpg.

Digital Soil Mapping in Minnesota: http://www.mngeo.state.mn.us/chouse/soil.html.

Soil Survey Geographic Database (SSURGO), Minnesota: https://gisdata.mn.gov/dataset/geos-ssurgo.

Soils and Landscapes of Minnesota by James Anderson, Jay Bell, Terry Cooper, and Dave Grigal: http://www.extension.umn.edu/agriculture/soils/soil-properties/soils-and-landscapes-of-minnesota/.

Average Annual Precipitation in Minnesota Cities: https://www.usclimatedata.com/climate/minnesota/united-states/3193.

Minnesota's Minimal Impact Design Standard Overview: https://stormwater.pca.state.mn.us/index.php/Overview_of_Minimal_Impact_Design_Standards_(MIDS).

Minnesota's Minimal Impact Design Standard Calculator: https://stormwater.pca.state.mn.us/index.php/MIDS_calculator.

Minnesota Stormwater Manual Design infiltration Rates: https://stormwater.pca.state.mn.us/index.php?title=Design_infiltration_rates.

Winter Maintenance Assessment Tool: https://stormwater.pca.state.mn.us/index.php/Winter_Maintenance_Assessment_tool_(WMAt).

Smart Salting Training Website: https://www.pca.state.mn.us/water/training.

Chloride Management Plan: https://stormwater.pca.state.mn.us/index.php?title=Chloride_Management_Plan.

Road Salt & Water Quality Website: http://www.pca.state.mn.us/programs/roadsalt.html.

Winter Parking Lot and Sidewalk Maintenance: https://www.pca.state.mn.us/sites/default/files/p-tr1-10.pdf.

Winter Maintenance Assessment Tool (WMAt): http://www.wintermaintenancetool.com/ or https://stormwater.pca.state.mn.us/index.php?title=Winter_Parking_Lot_and_Sidewalk_Maintenance_Factsheet.

Winter Parking Lot and Sidewalk Maintenance Factsheet: https://stormwater.pca.state.mn.us/index.php?title=Winter_Parking_Lot_and_Sidewalk_Maintenance_Factsheet.

The Real Cost of Salt Use for the Winter: https://www.pca.state.mn.us/sites/default/files/wq-iw11-06bb.pdf.

Smart Salting Certified Contractors: https://www.pca.state.mn.us/sites/default/files/p-tr1-01.xlsx.

MPCA Smart Salting Level 1 Certification: Buildings and Sidewalks https://www.pca.state.mn.us/water/salt-application-training.

MPCA Smart Salting Level 2 Certification: Road Maintenance Organizations https://www.pca.state.mn.us/water/salt-application-training.

Fortin Consulting Smart Salt Training http://fortinconsulting.com/training-and-presentation-calendar/.

Snow Removal: Do It Better, Cheaper, and Pollution-Free: https://www.pca.state.mn.us/living-green/snow-removal-do-it-better-cheaper-and-pollution-free.

Improved Winter Maintenance: Good Choices for Clean Water Mississippi Watershed Management Organization: https://www.youtube.com/watch?v=qc8Y-_Nmfmo.

Drought Tolerate Plants: https://stormwater.pca.state.mn.us/index.php?title=Minnesota_plant_lists.

Minnesota Native Plant Encyclopedia: https://webapps8.dnr.state.mn.us/restoreyourshore.

Living Landscape in Minnesota: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_022410.pdf.

Rainwater Harvesting: https://rainwaterharvesting.tamu.edu/rainwater-basics/.

How to Use Native Plants for Landscaping and Restoration in Minnesota:

Home Is Where the Habitat Is: https://www.dnr.state.mn.us/mcvmagazine/issues/2015/mar-apr/gardening-with-native-plants.html.

MN DNR Native Plant Suppliers and Landscapers Listing: https://www.dnr.state.mn.us/gardens/nativeplants/suppliers.html.

DNR Restore Your Shore Program: https://www.dnr.state.mn.us/gardens/nativeplants/suppliers.html.

MN DNR Invasive Species Listings: https://www.dnr.state.mn.us/invasives/index.html.

MN DNR Prescribed Fire Information: https://www.dnr.state.mn.us/firewise/prescribed.html.

MNTaxa Vascular Plants of Minnesota: https://www.dnr.state.mn.us/eco/mcbs/plant_lists.html.

DNR Information on Transplanting Lady's-Slipper Orchids: http://files.dnr.state.mn.us/assistance/backyard/gardens/native_plant/orchidtransplanting.pdf.

Minnesota Board of Water and Soil Resources, Native Vegetation/Seed Mixes: http://www.bwsr.state.mn.us/native_vegetation/index.html.

University of Minnesota Extension – Native Plants for Sustainable Landscapes.

Minnesota's Pollinators: https://www.dnr.state.mn.us/pollinators/index.html.

References for Plant Identification and Minnesota Ecology: http://files.dnr.state.mn.us/eco/nhnrp/annotated_bibliography.pdf.

Library of Rainwater Collection System Designs: http://www.rainharvest.com/library-of-rainwater-collection-system-designs.asp.

Design Criteria for Stormwater and Rainwater Harvest and Use/Reuse in Minnesota: https://stormwater.pca.state.mn.us/index.php?title=Design_criteria_for_stormwater_and_rainwater_harvest_and_use/reuse.

National Stormwater Calculator: https://www.epa.gov/water-research/national-stormwater-calculator.

Sample Specification for a Rainwater Catchment System: http://www.harvesth2o.com/adobe_files/ARCSA_Rainwater%20Code.pdf.

The Texas Manual on Rainwater Harvesting 2005: http://www.harvesth2o.com/adobe_files/ARCSA_Rainwater%20Code.pdf.

EPA Graywater Treatment Using Constructed Wetlands: https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=246852.

Constructed Wetlands for the Treatment of Grey Water in Campus Premises: https://link.springer.com/content/pdf/10.1007%2F978-3-319-11961-8_25.pdf.

NSF/ANSI 350 and 350-1, Onsite Water Reuse Treatment Systems: http://www.nsf.org/services/by-industry/water-wastewater/onsite-wastewater/onsite-reuse-water-treatment-systems.

Small-Scale Constructed Wetlands for Graywater and Total Domestic Wastewater Treatment: https://www.sswm.info/sites/default/files/reference_attachments/WAFLER%202008%20Small%20scale%20Constructed%20Wetlands.pdf.

Graywater Works: www.grayworks.com.

Englehardt, James D., Wu, Tinnting, and Tchobanoglus, George. 2013. "Urban Net-Zero Water Treatment and Mineralization: Experiments, Design." *Water Research*, 47. https://watersewerchallenge.alaska.gov/docs/Urban_NetZero_water_treatment_mineralization.pdf.

Guo, Tianjiao and Englehardt, James D. 2015. "Principles for Scaling of Distributed Direct Potable Water Reuse Systems: A Modeling Study." *Water Research*, 75. http://www.sciencedirect.com/science/journal/00431354/75 Or file:///C:/Users/stron081/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/Urban_NetZero_water_treatment_mineralization.pdf

Steiner, Lynn. *Landscaping with Native Plants of Minnesota*. Voyageur Press, 2011: https://www.amazon.com/Landscaping-Native-Plants-Minnesota-2nd/dp/0760341184.

Wester, Julia, Timpano, Kiara R., Cek, Demet, Lieberman, Debra, Fieldstone, Shaina C., and Broad, Kenneth. 2015."Psychological and Social Factors Associated with Wastewater Reuse Emotional Discomfort." *Journal of Environmental Psychology*, 42. https://pdfs.semanticscholar.org/3b84/1faeb402047056d71694c22032f9f1a0b9aa.pdf.

Glossary

Graywater Treatment:

Treatment of graywater must employ a preferred natural reed bed/wetland treatment and infiltration system or a reed bed/wetland treatment and recapture system for all onsite use where there is site space available, or, for tight urban spaces, treatment of graywater can employ an onsite manufactured treatment system for infiltration.

Environmentally Feasible:

If sufficient infiltration is feasible on the site (not an MPCA contaminated soils site), the treatment wetland is part of the required area for the animal and vegetative habitat and an asset to the design of the site.

Acceptable Soil Infiltration Conditions:

Natural or engineered soil must be able to treat and infiltrate or treat graywater onsite at the required rate during winter conditions.

Cost Effective:

Applies to situation in which the treatment of graywater per gallon is less expensive on a total cost basis (initial cost, operating cost over 20 years based on a discounted cash flow) than a potable water option.

Wetland Type Descriptors:[28]

- **Precipitation-Dominated Wetlands**
    - **Bogs:** Bogs obtain water primarily from precipitation and are characterized by sphagnum mosses dominating the floor of the bog and creating waterlogged, acidic conditions with low nutrient levels (USEPA 2010). Bogs prevent downstream flooding by absorbing precipitation. Because of the acidic, waterlogged conditions and low nutrient levels, only species that are specifically adapted to such conditions are able to live in bogs, resulting in many unique plant and animal species (USEPA 2010).
    - **Pocosins:** Pocosins are shrub- and tree-dominated landscapes with little standing water located at a slightly higher elevation than the surrounding landscape. Precipitation is the main water source, and although there is little standing water, the soil is saturated much of the year, resulting in waterlogged, nutrient-poor, and

[28] EPA Region 5 Wetlands Supplement: Incorporating Wetlands into Watershed Planning, March 2012.

acidic soils. Fires typically occur in pocosins every ten to 30 years during the spring or summer dry periods, and pocosins play a key role in maintaining a diverse tree and shrub population (USEPA 2010).

- **Vernal Pools, Playas, Prairie Potholes, Wet Meadows, and Wet Prairies**: Because of many similarities, these wetland types are sometimes categorized as marshes; however, unlike marshes, they receive water predominately from precipitation. Because these wetlands are isolated from surface waters, they do not typically discharge to surface waters, but many recharge groundwater (North Carolina State University [NCSU] Water Quality Group n.d.).

- **Surface Water-Dominated Wetlands:**
  - **Marshes:** Marshes are generally defined as wetlands frequently or continually inundated by water. All types of marshes receive most of their water from surface water; some are also fed by groundwater. Their vegetation is characterized by emergent soft-stemmed plants adapted to saturated soil conditions. Marshes are home to an abundance of plant and animal life due to high nutrient levels and neutral pH (USEPA 2010). They play an important role in recharging groundwater supplies, moderating stream flow, and settling pollutants to improve water quality (NCSU Water Quality Group n.d.).
  - **Riparian Forested Wetlands:** These wetlands receive water from rivers, streams, and lakes and are located across the United States. Standing water is present in the winter and spring, with little to no standing water during the summer and fall (NCSU Water Quality Group n.d.). Riparian forested wetlands act as a sink for pollutants from nonpoint sources (USEPA 2010). They also receive alluvial soil from floods, and as a result, they are very productive and are important ecologically as they serve as habitat for plant and animal species (NCSU Water Quality Group n.d.).
  - **Fens:** Fens are very similar to bogs, the main distinction being that fens receive water from groundwater (NCSU Water Quality Group n.d.). Fens are peat-forming wetlands; they have less acidic soil conditions and higher nutrient levels than bogs. Fens are located in northern regions characterized by low temperatures and short growing seasons (USEPA 2010). They can contribute to downstream waters and stabilize water tables by recharging groundwater at local aquifers (NCSU Water Quality Group n.d.).

Guideline S.3: Soil

Intent

To ensure the maintenance and restoration of healthy soils by documenting existing soil conditions, preserving and protecting benefits of existing soil, minimizing the impacts of construction, repairing soils to return to supportive conditions, and documenting soil maintenance practices to ensure ongoing optimal soil conditions.

Required Performance Criteria

Guidelines apply to all projects designated New Buildings and Major Renovations with site work site scope that includes an area of site disturbance that is greater than 3,000 s.f..

A. The soil conditions of the non-building area of the project site shall reference data from the NRCS WSS (websoilsurvey.nrcs.usda.gov) and shall be described. This description must include:
   1. A Site Soil Inventory Map (SSIM).
   2. A listing of which of the eight soil orders, 1,000 soil series, and seven slope classes that occur in Minnesota are present on the subject site based on the NRCS WSS.
   3. A listing of any soil limiting constraints for organic, wetland, or expansive clay soil's (shrink/swell) for the proposed project site uses.
   4. A listing of which of the three stages (as defined by this B3 Guideline) currently apply to the state of the project site's soils: natural, agricultural, or urban.
   5. A determination of whether the project is considered a greenfield (see definition below).
   6. A listing of specialized DNR defined native plant communities (NPCs).
   7. A mapping of any naturally occurring atypical soils (see definition below)
   8. Results from soil testing, at a minimum using the following rates for the following human soil stages: Natural: two soil tests per acre; Agricultural: three soil tests per acre; Urban: four soil tests per acre. Testing must be performed prior to construction and is recommended to be included in the geotechnical report. Additional testing at three and ten years after construction is recommended.

B. For projects developing on a greenfield site, the following should be submitted:
   1. A written rationale of the need to develop a greenfield site rather than a previously developed site.
   2. A plan for minimizing the disruption of existing, native, noninvasive vegetation.

C. Soil disturbance defined as grading, compacting, piling, tilling, scraping, storing, should be limited and the removal of soil within natural and agricultural human soil development spectrum areas should be ensured by the following and included in the Stormwater Pollution Protection Plan (SWPPP) for the project:
    1. Protecting intact soil with intact soil horizons using Site Soil Protection Zones (SSPZ); delineating exclusion barriers for these areas to ensure soil protection during construction.
    2. Soil in the following areas should not be disturbed:
        i. 40 ft. beyond the building perimeter.
        ii. 15 ft. beyond the primary roadway curbs, parking lots, main utility branch trenches, or impervious areas.
        iii. 5 ft. beyond walkways.
        iv. Any area under or closer than 1 ft. of tree driplines per 1 in. of diameter at breast height (DBH) trunk diameter (e.g., 12-in. DBH will require tree protection fence at least 12 ft. from the trunk).
        v. Areas within any identified stormwater management features.
        vi. Retaining walls within these areas may be employed as needed to maintain necessary grades.
    3. Trees shall be protected as individuals with the tree protection fence located outside the drip line, as defined above in C.2.iv, prior to site activities. Trees may be protected as groups if their canopies are within 10 ft. of each other, with tree fence protection zone distances as defined above in C.2.iv.
D. Soil management and erosion control plans should be created and implemented to protect the soil profile of the current site before, during, and after construction.
E. The bulk density of all unpaved pervious surfaces intended for seeding and planting shall have the following maximum bulk densities:
    1. Clays and Silts: 1.25 g/cm^3
    2. Loams: 1.40 g/cm^3
    3. Sands: 1.60 g/cm^3
F. A 50-ft. minimum of perennially rooted vegetated buffer for delineated wetland boundaries shall be maintained, established, or enhanced.
G. Topsoil from the project site shall not be sold or exported until all landscaped areas (tree, shrub, perennial, annual, or lawn plantings) have received an average 12-in. deep respread using soil from the project site. Existing site topsoil shall be stockpiled and protected, or topsoil should be imported for an average respread depth of 12 in. in all proposed planting and seeding areas. No topsoil should be screened with less than a 3-in. screen. Minimum respread depth is not required for green roofs.
H. At least 3.5% organic material by soil weight should be achieved in planting and seeding areas by adding sufficient organic matter to soil below this threshold.

I. If urban soils are present, in-site landscaped areas soil should be amended to mimic the physical and biological capabilities of natural and agricultural soils to achieve the following metrics:
   1. Soil texture: Determine which of the 12 soil classes are present on the site.
   2. A pH between 4.5 and 8.5.
   3. Nitrogen-Phosphorous-Calcium (NPK) fertility greater than medium, as tested by University of Minnesota Soil Testing Laboratory "Lawn, Garden, and Landscape" Soil Analysis Request Sheet.
   4. Meeting the following bulk density requirements for the listed soil types:
      i. Organics: less than 1.0 g/cm^3
      ii. Clays: less than 1.25 g/cm^3
      iii. Loams: less than 1.4 g/cm^3
      iv. Silts: less than 1.25 g/cm^3
      v. Sands: less than 1.6 g/cm^3
   5. Organic matter content should achieve a minimum of 3.5% by weight through the incorporation of Class A Biosolids, US Compost Council Certified Compost, and activated biochar (as defined in this B3 Guideline) in the following depths for the following soils:
      i. Predevelopment: incorporated (e.g., V-ripper or Paraplow) into site soils to a minimum depth of 24 in.
      ii. Postdevelopment: incorporated (e.g., V-ripper or Paraplow) into site soils to a minimum depth of 12 in.
      iii. Minor Modification Amendments: applied as topdressing or incorporated into site soils to a minimum 6-in. depth.
   6. Soil should be modified to achieve the following NRCS infiltration rate for the following conditions:
      i. Natural stage soils improved to have a higher infiltration rate than Group A.
      ii. Agricultural stage soils improved to have a higher infiltration rate than Group B.
      iii. Urban stage soils improved to have a higher infiltration rate than Group C.
      iv. Stormwater infiltration stage soils improved to have a higher infiltration rate than Group A.
   7. A cation exchange capacity (CEC) of at least 15 should be achieved.
   8. A base saturation percentage of at least 30% should be achieved.
   9. A mycorrhizae count of at least two Glomus species per ounce of soil should be achieved.

J. Atypical soils: If the project has atypical soils or substrates for a specialized NPC, these shall be preserved in the landscaped areas of the site according to the following:
   1. All naturally occurring atypical soils of an area greater than 5,000 sq. ft. shall be preserved as required to support NPCs in seeps, fens, bogs, bedrock outcrops, sand blow-outs and sand dunes (as defined by DNR Natural Heritage and Nongame Research Program), Spodosols, Histosols, Psamment, Entisols, and Sodic soils.
   2. The boundaries of these atypical soils and substrates should be field mapped, marked, and delineated with visible flagging on project site. This NPC delineation prohibits entry of any vehicles with tires before, during, or post construction. These soils or substrates should not be disturbed, buried, blasted, or removed from their original location onsite.
   3. Minnesota Biological Survey staff of the DNR should be consulted to create and execute the following:
      i. A specialized, NPC planting plan with a conservation status rank (S-ranks) of S1 or S2 that most appropriately matches the site's atypical soils and substrates.
      ii. Guidance on site preparation (weed and erosion control), site drainage, and revegetation (seeding, planting, etc.), and long-term maintenance (fire management, weed control, etc.) for that specialized NPC.
      iii. Operations and maintenance plan to ensure that this restored vegetation and naturally occurring atypical soil is rigorously protected and maintained.
   4. Upon complete installation of this specialized NPC, a perimeter exclusion fence should be installed with one permanent, outdoor sign (dimensions at least 24 in. x 36 in.) interpreting the specialized NPC using Tilden's 5 Principles of Interpretation.

Note: Specialized planting areas may count against local open space ordinances at a 3:1 ratio (i.e., 1 sq. ft. of specialized, NPC will equal 3 sq. ft. of local open space). Also note that other vegetation requirements are listed under S.1 and S.4.

Recommended Performance Criteria

K. If the soils are NRCS-defined udorthents or udipsamments, then the results of a Modified Philip-Dunn Infiltrometer measurements of saturated hydraulic conductivity with at least four tests taken per acre should be included in the descriptions of the site soils.
L. A CEC of more than 15 should be maintained.
M. A pH factor of the soil between 5.5 to 8.5 pH should be maintained.

Meeting the Guidelines

The SSIM should be developed using an engineering scale typical to a development of site size (e.g., 1 in. = 30 ft., but no coarser than 1 in. = 100 ft.), and labeled with a bar scale and north arrow. An interpretive legend of symbols, colors, shades, hatched markings, etc. and current NRCS soil terms should be used. The SSIM as a layer on the site's legal land survey should be mapped with topographical controls, benchmarks, etc. The NRCS WSS: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm should be used to determine the following:

- The eight soil orders, 1,000 soil series, and seven slope classes present on the project site.
- The soil limiting constraints for organic, wetland, or expansive clay soils for the proposed development uses (buildings, roads, parking, trails, landscapes).
- The three stages that currently apply to the state of the site's soils: natural (never plowed, often containing O or E horizons), agricultural (standard cultivation practices with A, B, C horizons), or urban (buried horizons, missing major horizons, such as A or B or C; C or R horizons at the surface plane).

Additional information on using the NRCS WSS is listed under Appendix S-3.

The SSIM should identify where one or more of the state's soil orders are encountered intact, as these areas will need to be actively protected from filling or compaction per guideline S.3B. Existing natural soil horizons (A, B, C, R or O, A, E, B, C, R or A, E, B, C, R) should be preserved. The site's damaged soils should be mapped, classified, protected, and/or mitigated.

Exclusion barriers for any identified SSPZ should be installed prior to site mobilization to ensure soil protection during the construction process. Access by vehicles with tires should be prohibited and a perimeter exclusion fence a minimum of 42 in. in height implemented

Atypical, naturally occurring soils, and substrates greater than 5,000 sq. ft. in area discovered on subject site should be identified, mapped, delineated, and preserved. These soils and substrates are required to support specialized (S1 and S2 rank) NPCs found in Minnesota's seeps, fens, bogs, bedrock outcrops, sand blow-outs, and dunes.

The specialized NPC and atypical soils may necessitate the use of other strategies to increase site biomass to match the ecosystem province in which the subject site occurs. In those cases, the use of green walls (vines on trellis), green roofs (extensive), and tree canopies over impervious surfaces that do not increase building footprint but do increase overall site biomass are encouraged.

Soil management and erosion control plans must list activities used to protect the soil profile of the current site before, during, and after construction. The following definitions should be used:

- Natural: never plowed, often containing O or E horizons with A, B, C horizons also.
- Agricultural: standard cultivation practices with A, B, C horizons present.
- Urban: buried horizons; missing major horizons, such as A or B or C or E or R horizons within 30 in. of the existing ground surface plane.

Raising or maintaining the percentage of organic material content in the existing or imported site soil will help build the site's natural mycorrhizae and microbial population and enhance the health of the soil. The soil in planting and seeding areas should be tested and amended with organic material as needed to achieve at least 3.5% organic material by soil weight.

Soil testing should be done using the University of Minnesota's Soil Laboratory sampling protocol at the following rates for the following human soil stage: natural: 1 soil test per acre; agricultural: 3 soil tests per acre; urban: six soil tests per acre. Testing during occupancy should be submitted at the following rates for the following human soil stages: natural: two soil tests per acre; agricultural: three soil tests per acre; urban: four soil tests per acre.

Minnesota Soil Background

Of the 12 soil orders in the United States, Minnesota contains eight: 32% Mollisols (prairie); 27% Alfisols (deciduous forest); 9% Inceptisols (mixed forest); 18% Entisols (boreal forest or river floodplains); 5% Histosols (peat marshes or blanket bogs); 1.0% Vertisols (Glacial Lake Agassiz/Red River Valley); 0.2% Spodosols, (sandy saturated coniferous boreal forest). These soil orders are inextricably linked to the state's parent material climate and the vegetation of its dominant ecosystem provinces.

Surface transported glacial parent materials of the Wisconsin Ice Age has been the most influential factor in forming Minnesota's soils. The dominant, surface glacial parent materials are till, outwash, and moraines from the Des Moines and Superior Lobes. The shale-rich (Canadian sedimentary bedrock) Des Moines Lobe entered Minnesota from the northwest and terminated in Des Moines, Iowa. The Superior Lobe that scraped the Canadian Shield was iron-rich, igneous rock (basalt, granite). The Superior Lobe entered Minnesota from the northeast and ended its journey in north central Minnesota.

Minnesota's most recent glaciation, the Wisconsin Ice Age (about 10,000 BP), was the Laurentian Ice Sheet that covered about 90% of the state for thousands of years, with ice anywhere from hundreds to thousands of feet thick. The state's soils are geologically new and extremely fertile. Much of the state's Entisols and Inceptisols (27% of the state) are less than a thousand years old. Mollisols, the state's dominant soil order, covers about one-third (32%) of Minnesota. Minnesota's Mollisols are among the richest soils on earth and typically greater than 5,000 years old. One acre of Minnesota Mollisols yield on a per-acre basis three to five times the agricultural lands of the southern and southeastern United Stated, and ten times more than ancient tropical soils. It is strongly discouraged to develop or disturb current Minnesota farmland.

Ancient or Glacial Lake Agassiz was located in the northwestern portion of Minnesota, now called the Red River Valley. At its maximum, Glacial Lake Agassiz covered most of Ontario and Manitoba, dwarfing the Great Lakes in size. The Minnesota River Valley (the Glacial River Warren) was the outlet channel for Glacial Lake Agassiz. The fluvial force of emptying Lake Agassiz carved a mile wide canyon, hundreds of feet deep. After this glacial meltwater formed Lake Agassiz, lacustrine parent material precipitated in the lake. At this location, fertile clays, with abundant illite, smectite, and vermiculite, were deposited. Because of high moisture content, these Vertisols are much harder to cultivate than Mollisols. However, these Vertisols, are as exceptionally fertile as Mollisols. As these are poorly drained shrink-and-swell-prone clays on a planar flat landscape they are generally not well-suited for construction activities and are recommended to be used only for row crop agriculture.

Submittal Requirements

Predesign:

- S.3A: Submit soil testing results as required by guidelines and a listing of the human soil stage(s) of site.

Design:

- S.3A: Submit description of site soils, including the following: a SSIM, test results, and sampling locations; which of the eight soil orders, 1,000 soil series, and seven slope classes are present onsite; the soil development limiting constraints for organic, wetland, or expansive clay soil; which of the three stages apply to the current state of the subject site's soils; whether the site is considered a greenfield; and a listing of NPCs identified onsite.
- S.3C: Submit identified SSPZ and delineated exclusion barriers/zones.
- S.3I: Submit urban soil restoration amendment plan of future landscaped area in 1,000 sq. ft. units.
- S.3J: Include results of preliminary coordination with Minnesota Biological Survey staff for NPC restoration, including preliminary planting list, details of site preparation, drainage, and revegetation.
- S.3K: If soils are udorthents or udipsamments, submit saturated hydraulic conductivity test results.

Final Design:

- S.3B: If project is developing on a greenfield site, submit rationale for developing on site and a site plan documenting minimization of the disruption of existing, native, non-invasive vegetation.
- S.3C: Submit site plan delineating limits of soil disturbance during development, including SSPZ.
- S.3D: Submit a soil management and erosion control plan.
- S.3E (and S.3O if pursuing): Submit Contract Documents section with specifications for bulk density requirements for all unpaved pervious surfaces.
- S.3F: If wetlands are present on site, submit site plan noting 50-ft. vegetated buffer for delineated wetland boundaries.

- S.3G: Submit Contract Documents, which prohibits selling or exporting any topsoil from project site, and delineate onsite plan storage areas for site's topsoil that will be reused.
- S.3H: Submit Contract Documents specifying that the soil must have a minimum of 3.5% organic material by soil weight.
- S.3I: Submit Contract Documents with specifications for urban soil restoration amendment: Soil texture, pH, NPK fertility, bulk density, organic matter, infiltration rate, CEC, base saturation, and mycorrhiza count requirements for each 1,000 sq. ft. of site landscape area.
- S.3J: Results of coordination with Minnesota Biological Survey (MBS) staff for NPC restoration, including planting list, details of site preparation, drainage, revegetation; design of permanent outdoor interpretive sign meeting guideline requirements in site operations and management (O&M) manual to vigorously protect and maintain restored vegetation on these atypical soils with MBS and DNR staff guidance.
- S.3L: Submit Contract Documents requiring CEC of at least 15.
- S.3M: Submit Contract Documents requiring pH factor between 5.5 and 8.0.

Closeout:

- S.3A: Submit soil reports as required.
- S.3C: Note any incursions into the SSPZ and remedies employed to mitigate soil damage.
- S.3J: Site O&M manual for restored NPCs on atypical soils, as created in coordination with MBS staff.

Occupancy – Submitted annually for ten years:

- S.3A: Submit ongoing soil sampling as required at least every three years.

Additional Resources

DeepRoot tree and stormwater products: http://www.deeproot.com/.

MN DNR Minnesota Biological Survey. Conservation Status Ranks for Native Plant Community Types and Subtypes (S-ranks): http://www.dnr.state.mn.us/npc/classification.html.

MN Board of Water & Soil Resources Wetland Delineation Guidance: http://www.bwsr.state.mn.us/wetlands/wca/Wetland_Delineation_Method_Guidance7-1-10.pdf.

MN DNR County Biological Survey, County Maps: http://www.dnr.state.mn.us/eco/mcbs/maps.html.

MN PCA - Brownfields: https://www.pca.state.mn.us/waste/brownfields.

MN PCA - Dominant soil orders: https://stormwater.pca.state.mn.us/images/e/e6/Minnesota_dominant_soil_orders.jpg.

Dominant Soil Material Mapping Statewide: http://anokaequine.com/_mod_files/ce_images/photoalbum/mn_soil_content.jpg.

Urban, James. *Up By the Roots*. International Society for Arboriculture, 2008: http://www.jamesurban.net/up-by-roots/

USDA Web Soil Survey (WSS): https://stormwater.pca.state.mn.us/images/thumb/b/bd/Minnesota_dominant_soil_suborders.jpg/300px-Minnesota_dominant_soil_suborders.jpg.

UMN Soil Testing: http://soiltest.cfans.umn.edu/testing-services.

United States of America Department of Agriculture (USDA) Web Soil Survey: http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

US Compost Council Certified Compost: https://compostingcouncil.org/.

Wovcha, Daniel. Delaney, Barbara, and Nordquist, Gerda. *Minnesota's Saint Croix River Valley and Anoka Sandplain: A Guide to Native Habitats*. University of Minnesota Press, 1995. https://www.upress.umn.edu/book-division/books/minnesotaas-st-croix-river-valley-and-anoka.

Glossary

Activated Biochar:

Activated Biochar is biomass (e.g., woodchips) produced via pyrolysis (400–500 degrees Celsius), and activated to allow immediate application.

Landscaped Areas:

Nonbuilding or paved areas on which plants will be grown in soil (trees, shrubs, perennials, annuals, turf) or prairie, wetland, woodland, buffers.

NRCS:

Natural Resource Conservation Service, within the USDA.

Soil Orders:

Coarsest resolution of soil taxonomic nomenclature, defined by NRCS. Twelve found worldwide; eight found in Minnesota.

Soil Series:

Finest resolution of soil taxonomic nomenclature. >19,000 found in the USA; >1,000 found in Minnesota, defined by NRCS.

Slope Classes:

Classification of the slopes present on a project site based on percentage grade (slope A B C D E F G, where A is shallowest <2%. G is steepest >35%).[29]

Human Soil Stages:

- Natural: never plowed, often containing O or E horizons with A, B, C horizons also.
- Agricultural: standard cultivation practices with A B C horizons present.
- Urban: buried horizons; missing major horizons, such as A or B or C or E or R horizons within 30 in. of existing surface plane.

Soil Texture Classes & Triangle:

Twelve classes representing percentage ratios of the fine earths (<2 mm) or mineral portions of soil: sand, silt, clay. For example, in the case of sandy loam, the first word is a modifier (sandy) of the dominant mineral portion (loam).[30]

Infiltration rate scale uses NRCS Infiltration Rate Scale, which is based on the speed, measured in inches per hour, at which gravity water passes through soil. Listed as A, B, C or D. A is the fastest (>1.1 in./1 hr.); D is the slowest (<0.05 in./1 hr.).[31]

[29] https://www.agry.purdue.edu/soils_judging/review/slope.html
[30] http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1130447039&topicorder=2&maxto=10
[31] http://www.bwsr.state.mn.us/outreach/eLINK/Guidance/HSG_guidance.pdf

Bulk Density:

Soil compaction rate is measured in grams of density within a fixed volume of cubic centimeters.[32]

Cation Exchange Capacity (CEC):

Capacity of a soil to retain macro and micro nutrients during standard weathering. 0 (zero) is an exhausted deeply weathered soil; 15 is adequate; >25 is a fertile soil.[33]

Base Saturation Percent:

Anion elements (calcium, sodium, magnesium) as a percentage of nutrient fertility: >35% is a young fertile soil; <20% is a weathered acidic nutrient-poor soil.[34]

Topsoil:

Defined as an A horizon with a Munsell soil color darker than 10YR 4/3.

Atypical Soils:

Naturally occurring atypical soils are soils with any of these characteristics:

- Greater than 40% clay fraction by volume.
- Greater than 30% organic matter by weight.
- Greater than 80% sand fraction by volume.
- Bedrock within 15 in. of the original ground surface elevation.
- Hydric soils as defined by 1987 Wetland Conservation Act.

[32] http://www.deeproot.com/blog/blog-entries/the-most-important-factor-for-growing-healthy-trees-2
[33] http://www.extension.umn.edu/agriculture/nutrient-management/soil-and-plant-sampling/soil-cation-ratios/
[34] http://www.cbxproducts.com/3_1Soil_CationExchange.html

Guideline S.4: Vegetation

Intent

To optimize the ecological function of project sites by restoring Minnesota's native vegetation, protecting natural areas, conserving existing site features, and selecting vibrant and appropriate vegetation to ensure the optimum functioning of ecosystems.

Required Performance Criteria

Guidelines apply to all projects designated New Buildings and Major Renovations with site work site scope that includes an area of site disturbance that is greater than 3,000 s.f. OR Area of imperviousness (footprint of building plus site impervious area) renovated that is greater than 2,000 s.f..

A. New construction projects shall not select sites which contain any of the following:
   1. Prime farmland (as defined by the NRCS WSS).
   2. Farmland of state significance (as defined by the NRCS WSS).
   3. Former municipal, township, or county parkland.
   4. Former federally protected lands.
   5. Areas covered by a conservation easement.

Note: On areas under a conservation easement, the only allowed activity is restoration to the original NPC, per the DNR's County Biological Survey (CBS).

B. The following tree conditions shall be established:
   1. Combined trunk areas of all trees (including deciduous and coniferous) evaluated at 10-year estimated maturity post construction and measured by calculating the trunk area at 4.5 ft. above the ground (i.e., DBH):
      i. Tallgrass aspen parkland and savanna: 3 to 6 sq. ft. of trunk area per acre.
      ii. Southern and southeastern hardwood deciduous: 7 to 12 sq. ft. of trunk area per acre.
      iii. Northern deciduous: 5 to 10 sq. ft of trunk area per acre.
      iv. Boreal conifers: 8 to 14 sq. ft. of trunk area per acre.
   2. Required minimum of tree diameter as evaluated in DBH to trunk area at ten years maturity, and number of large, medium, and small trees needed to achieve this requirement:

Type of Tree Plant Community	Sq. Ft. (144 sq. in./1 sq. ft.) Trunk Area	Number of Large Trees Only (0.66 sq. ft. ea/12-in. DBH)	Number of Medium Trees Only (0.39 sq. ft. ea/7-in. DBH)	Number of Small Trees Only (0.20 sq. ft. ea/3-in. DBH)
Prairie	0	0	0	0
Tallgrass Aspen Parkland & Prairie Savanna	2–4	3–6	5–11	10–20
South & Southeast Hardwood Deciduous	4–7	6–11	11–18	20–35

Type of Tree Plant Community	Sq. Ft. (144 sq. in./1 sq. ft.) Trunk Area	Number of Large Trees Only (0.66 sq. ft. ea/12-in. DBH)	Number of Medium Trees Only (0.39 sq. ft. ea/7-in. DBH)	Number of Small Trees Only (0.20 sq. ft. ea/3-in. DBH)
Northern Deciduous	3–6	5–10	8–16	15–30
Boreal Coniferous	4–7	6–11	11–18	20–35

Type of tree plant community shall be established based on the DNR Ecological Provinces Map.

i. Sample Ratios of Trunk Areas at DBH

DBH Inches	Area Square Inches	Area Square Feet
10”	78 sq. in.	0.55 sq. ft.
15”	177 sq. in.	1.23 sq. ft.
20”	314 sq. in.	2.19 sq. ft.
25”	491 sq. in.	3.41 sq. ft.

ii. Annual Tree Growth Diameter Increase in Inches DBH with trees planted at ~1-in. DBH/2.5-in. Caliper:

Tree Type Size	Annual Rate Increase in Inches of DBH	DBH in Inches at Ten Years	Area of Trunk at Listed DBH in Square Inches at Ten Years	Area of Trunk at DBH in Square Feet at Ten Years
Large	>1”	~11”	95 sq. in.	0.66 sq. ft.
Medium	>3/4”	~8 1/2”	57 sq. in.	0.39 sq. ft.
Small	>1/2”	~6”	28 sq. in.	0.20 sq. ft.

iii. Adequate tree soil volumes should be achieved. Where trees are surrounded by hard surfaces (e.g., sidewalks, patios, driveways, car parks, plazas, parking islands), suspended pavement techniques, structural soils, or other comparable methods such as larger tree openings to provide adequate rootable soil volumes should be used. Minimum volume of rootable soil volume per tree is:
(1) Small trees (e.g., Serviceberry - Amelanchier): 400 cu. ft.
(2) Medium trees (e.g., Ironwood - Ostyra): 800 cu. ft.
(3) Large trees (e.g., Hackberry - Celtis): 1,200 cu. ft.
If using structural soils, multiply the total soil volumes above by five to obtain equivalent volume of soil useable by the tree. If above soil volumes cannot be met, trees species requiring smaller soil volumes should be selected. Where applicable, suspended pavement or comparable methods should be utilized to allow tree roots under hard surfaces to access adjacent open space.

iv. Adequate tree diversity should be achieved to limit susceptibility of site to disease and increase ecological resilience: Tree genera of like form should be planted in large single species tree plantings, such as allees or

formal groupings. For example, Kentucky coffeetree (Gymnocladus), honey locust (Gleditsia), and black locust (Robinia) are similar in form, structure, and leaf texture but are three different genera not susceptible to the same pests and diseases. The following numbers of tree generas should be achieved:

(1) Three genera on sites of fewer than 2 acres.
(2) Five genera or more on sites of 2 to 5 acres.
(3) Seven genera or more on sites of 5 to 10 acres.
(4) Nine genera or more on sites of 10 to 15 acres.
(5) Twelve genera or more on sites of 15 to 20 acres.
(6) Fifteen genera or more on sites of 20 to 40 acres.
(7) Eighteen genera or more on sites of 40 to 100 acres.
(8) Twenty genera or more for sites of greater than 100 acres.

3. Tree planting requirements: At time of tree planting, the following criteria should be met:
   i. All soil/mulch/media covering trunk flare removed.
   ii. Point of stem/root union exposed at original ground surface elevation (see UMN Extension).
   iii. Caliper size of all trees limited to 2.5 in. at planting.
   iv. All stem girdling roots (SGR) on trees rejected or removed (see UMN Extension).
   v. Metal baskets and burlap removed from balled-and-burlapped (B&B) root balls to 12 in. below soil level.
   vi. Trees should not be planted deep in the planting hole to stabilize them.
   vii. Mulch should not be placed against tree trunk deeper than 1-in. deep; tree stem/root union should be planted 1 to 3 in. higher than surrounding ground plane elevation.
   viii. Newly planted trees should be watered at a rate of 1.5 gal. per caliper in. per 3 calendar days from May through September, at the following intervals. Watering bags are recommended.
      (1) Year 1: At least every three days
      (2) Year 2: At least weekly
      (3) Year 3: At least every two weeks

      See soil section for acceptable drainage and bulk density rates for soils in planting areas.
   ix. Crowns should not be pruned at planting to balance root and crown volumes.
   x. Broken branches should be pruned and removed to develop a single central leader. Codominant branches that exceed half of tree trunk diameter at branch/trunk attachment point should be removed.
   xi. Trees in containers that are rootbound should be box cut (see UMN Extension).

   The following should be evaluated and implemented if feasible:

   xii. Contracting growing trees for orders exceeding 20 trees total.
   xiii. Growing bare root stock in Missouri gravel bed nursery for half the growing season prior to planting out to create a large vigorous tree root system (see UMN Extension).
   xiv. Using arborist's wood chips, mulch to a depth of up to 6 in. deep, over tree root systems but not against trunks. If trees are unstable in their planting hole reject trees or require one year of tree staking.
   xv. Grade all landscaped areas to slope towards tree plantings.

C. The vegetation selected shall be subject to the following and selected in coordination with the animal and vegetation requirements listed under S.1 and animal habitat requirements listed under S.5:
   1. Existing, noninvasive, nonnative vegetation should not be removed solely in order to achieve the amount of native vegetation required under S.1A.
   2. The selection of herbaceous plantings for prairies, wetlands, savannas, parklands, and forests shall use the methodology (steps 1–5) found in MnDOT's Native Seed Mix Design for Roadsides (2014): www.dot.state.mn.us/environment/erosion/pdf/native-seed-mix-dm.pdf.
   3. The required strata are a ground layer less than 48 in. tall and a tree canopy greater than 78 in. tall.
   4. Keystone species shall be selected according to the following restoration goals:
      i. Where savanna, south and southeastern hardwood deciduous, and northern deciduous are being restored, one of the selected trees in the cohort population shall be included: burr oak (Quercus macrocarpa)
      ii. Where prairie and savanna are being restored, one of the selected trees in the cohort population should be included: American hazelnut (Corylus americana) or beaked hazelnut (Corylus cornuta).
      iii. Where prairie, tallgrass aspen parkland, and savanna are being restored, two of the selected grasses in cohort population should be included: dry/xeric grasses: little bluestem (Schizachurium scoparium) and side oats gramma (Bouteloua curtipendula); medium/mesic grasses: big bluestem (Andropogon gerardii) and Indian grass (Sorgastrum nutans); wet/hydric grasses: switch grass (Panicum virgatum) and prairie cord grass (Spartina pectinata).
      iv. Where south and southeastern deciduous hardwood and northern deciduous and boreal conifers are being restored, one of the selected trees in the cohort population should be included: serviceberry (Amelanchier canadensis).
      v. Where boreal conifers are being restored, one of the selected trees in the cohort population should be included: white pine (Pinus strobus).
   5. The coefficient of conservancy for all B3 sites with wetland hydrology at planting must be greater than four as calculated by the floristic quality assessment (FQA) method (per Wilhelm 1977). In areas adjacent to water bodies or wetlands or rivers or streams, a series of exploratory holes 12 in. deep should be dug between April and November. If water appears and persists in the hole for more than two hours after excavation, an FQA must be performed.
   6. Invasive species on site should be determined using the *Invasive Species County Weed Guideline*. If the site does contain invasive species, a mitigation and maintenance plan as defined by the Minnesota Department of Agriculture should be created or implemented.
   7. All vegetation must be selected in accordance with the correct local USDA hardiness zones.

D. Pollinator friendly vegetation:
    1. Neonicotinoid-free sites: All project plantings must use a written chain of custody method to verify neonicotinoid-free claims. Reject plants that have been neonicotinoid treated, or that do not have a clear, verifiable chain of custody of being neonicotinoid-free. This requirement also applies to trees, shrubs, and vines.
    2. Site plantings should be selected so that at least 50% by quantity of all trees, shrubs, groundcovers, vines, and herbaceous perennials are insect pollinated, and rich in pollen and/or nectar.
    3. Blooming pollinator plants should be provided for all three seasons of blooms (spring, summer, fall), with at least two different species blooming during each season.
    4. Coincidently blooming pollinator plants should be clustered in large groupings to reduce expended energy of insect pollinators.
    5. Abundant human and natural structural enhancements should be provided for insect pollinators (e.g., dead tree snags, downed tree logs, sand baths, bee skeps, solitary beehives, mason bee houses, green roofs, and green walls).
    6. Cultivars with double and triple petal flowers that do not produce pollen or nectar should be minimized.

Note: This guideline has been developed in response to Minnesota Executive Order 16-07, which also outlines requirements of specific state agencies, departments, boards, and committees not listed here.

E. Achieve biomass target according to major ecosystem of site, as measured in biomass per area of vegetated site area, estimated at ten years post-occupancy according to the major ecosystem characterization from DNR:
    1. Prairie: 1.1 kg per square meter or 2.03 pounds per square yard.
    2. Tallgrass aspen parkland and savanna: 0.9 kg per square meter or 1.66 pounds per square yard.
    3. South and southeastern hardwood deciduous forest: 0.7 kg per square meter or 1.29 pounds per square yard.
    4. Northern deciduous and boreal conifer: 0.6 kg/per square meter or 1.11 pounds per square yard.

    These biomass targets do not apply to the restoration of specialized NPCs installed pursuant to S.3K: Atypical Soils.
F. Site should be designed so that the entire site albedo is at least 0.25 as evaluated using the B3 Albedo Calculator.

Recommended Performance Criteria

G. Use a diversity of native plants to express multiple design styles (do not exceed 500 of any single herbaceous perennial species or cultivar; 50 of any single shrub species or cultivar; 10 of any single tree species or cultivar). DNR's 49 designated terrestrial invasive plants should not planted.
H. Subject sites with existing NPCs should be protected from development, and DNR Heritage Division staff consulted for restoration of existing native plant areas.
I. Achieve an entire site albedo of at least 0.3 as evaluated using the B3 Albedo Calculator.

Meeting the Guidelines

In the Predesign and early design of the project, determine ideal spatial needs for existing or new development. Critical sites for preservation or restoration on the project site as defined by the B3 Guidelines should be identified, and the type of buildings and related infrastructure that will be required for the developed areas and their spatial requirements should be determined. After a site has been selected, create potential spatial footprints that preserve any critical sites identified during the Predesign phase.

Select a site where the proposed building and infrastructure will have minimal disturbance on the existing vegetation and the supporting soil and hydrologic conditions. Areas of vegetation or high quality areas for restoration should be identified for protection or restoration during the design and construction process.

Through the design process, techniques should be used to minimize negative impacts on soil, water, and vegetation on the site and on adjacent sites that are to be preserved or restored. Develop details and specifications that support the use of native plantings, maintain existing biodiversity, and promote enhancement of site conditions per the B3 Guidelines.

A preconstruction meeting should be held to identify requirements for protection/preservation of vegetation during and after the construction process. Submittals should be monitored for compliance with plans and details. Bidders should be made aware of specific responsibilities for integrating the onsite vegetation management with connections to vegetation on adjacent sites. Existing plants and trees that will remain should be protected, and soil and water conditions maintained or improved to promote and improve vegetation growth.

An O&M manual should be created to protect and maintain onsite vegetation. The existing conditions of the vegetation should be documented, as should the reason the vegetation was preserved or enhanced, and its ability to function in its current capacity. The necessary enhancements needed to accommodate a different building type in the future should be noted, as well as what the enlargements or reductions in spatial area would be.

Pollinator friendly plantings should be selected from the lists below for compliance with S.4H:

- DNR Pollinator BMPs and Habitat Restoration Guidelines: http://files.dnr.state.mn.us/natural_resources/npc/2014_draft_pollinator_bmp_guidelines.pdf.
- University of Minnesota Bee Lab, Plants for Minnesota Bees: https://www.beelab.umn.edu/sites/beelab.umn.edu/files/plants_mn_bees.pdf.

To calculate the site albedo: On the project site plan, measure all areas in square footage that are exposed to sun during noon on June 22nd and determine the albedo value of the area according to its color. For living plants, use expected growth in ten years after the project is completed for square footage.

Calculate the total proposed site albedo using Appendix S-4: Site Albedo Calculator. The total site albedo as determined by this calculation must be at least 0.3 (or 0.25 if pursuing S.4N). Submit a site plan with each site material and albedo values identified and the completed Appendix S-4.

Using https://www.pca.state.mn.us/water/floristic-quality-assessment and the available FQA calculator and instructions, ensure that the site achieves at least a score of 4.0.

Submittal Requirements

Predesign

- S.4A: Identification of any critical site conditions.
- S.4J: Plant design matrix for genera, species, and structural diversity of planting that meet S.4K (and other
- relevant guidelines).

Design:

- S.4B: Verification of intended compliance and preliminary calculations of tree trunk areas, tree soil volumes, tree soil diversity and preliminary specifications outlining tree planting methods.
- S.4C: Verification of intended compliance and preliminary calculations for all required vegetation conditions, including planting plan for each plant category identified in the Predesign matrix for genera, species, and structural diversity of planting guidelines, updated as needed.
- S.4D: Verification of preliminary selection of pollinator friendly plantings.
- S.4E: Identification of major ecosystem and preliminary intended method of compliance of biomass target.

- S.4J: (and S.4N if pursuing): Completed preliminary Appendix S-4 Albedo Calculator demonstrating anticipated design compliance with albedo limits.

Final Design:

- S.4B: Verification of language mandating compliance in construction documents for tree trunk areas, tree soil volumes, tree soil diversity and specifications outlining tree planting methods.
- S.4C: Verification of compliance method in construction documents for all required vegetation conditions, including planting plan for each plant category identified in the Predesign matrix for genera, species, and structural diversity of planting guidelines, updated from prior iterations.
- S.4D: Verification of selection of pollinator friendly plantings.
- S.4E Identification of major ecosystem and construction documents requiring compliance with biomass target.
- S.4F (and S.4I if pursuing): Completed Appendix S-4 Albedo Calculator demonstrating compliance with albedo limits. A site plan showing the location and size of areas with different reflective characteristics and their assigned albedo values should be included.
- S.4D: Verification of selection of pollinator friendly plantings and specifications prohibiting using neonicotinoid products during the establishment, maintenance, and operation of the site.
- S.4G: Planting plan demonstrating diversity of native plant species.
- S.4H: Documentation of NPCs, including site plan and documentation of correspondence and implementation of recommendations of DNR Heritage Division staff.

Closeout:

- S.4B: Verification of language mandating compliance in construction documents and guidelines requirement compliance if trees are surrounded by hard surfaces. Final planting plan for each plant category identified in the final design matrix for genera, species, and structural diversity of planting that meet required genera diversity, updated as needed and verifying that substitutes were not implemented for more than 5% of trees, shrubs, vines, or perennials.

Additional Resources

Appendix S-4 Site Albedo Calculator

Coffin, Barbara and Pfannmuller, Lee. 1988. *Minnesota's Endangered Flora and Fauna*. Minnesota: University of Minnesota Press.

Dirr, Michael. 1990. *Manual of Woody Plants*. Illinois: Stipes Pub.

Hightshoe, Gary. 1988. *Native Trees, Shrubs, and Vines for Urban and Rural America: A Planting Design Manual for Environmental Designer*. New York: Van Nostrand Reinhold.

International Society of Arboriculture: www.isa-arbor.com/publications/tree-ord/ordprt3d.aspx.

MacDonagh, L. Peter, 2005. *Minnesota Soil Bioengineering Handbook*. Minnesota: MnDOT.

Minnesota Board of Water and Soil Resources: www.bwsr.state.mn.us/index.html.

Minnesota Department of Agriculture, Invasive Species: https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21429.

Minnesota Department of Agriculture Conservation Funding Guide: http://www.mda.state.mn.us/protecting/conservation/practices/invasivemgmt.aspx.

MN DNR, Invasive Species: http://dnr.state.mn.us/invasives/terrestrialplants/index.html.

MnDOT, Native Seed Mix Design for Roadsides, May 2010. www.dot.state.mn.us/environment/erosion/pdf/native-seed-mix-dm.pdf.

Smith, Welby. 2008. *Trees and Shrubs of Minnesota: The Complete Guide to Species Identification*. Minnesota: University of Minnesota Press.

Swink, Floyd and Wilhelm, Gerould. 1994. *Plants of the Chicago Region*. Indiana Academy of Science.

Sutton, Richard K., ed. 2015. *Green Roof Ecosystem.* Springer International Publishing. (See Chapter 11.)

Urban, James. *Up By The Roots*, International Society for Arboriculture 2008: http://www.jamesurban.net/up-by-roots/.

University of Florida Landscape Plants guidance by Ed Gillman http://hort.ifas.ufl.edu/woody/.

USDA Electronic Field Office Technical Guide (eFOTG): www.nrcs.usda.gov/technical/.

Wild Ones Pollinator Garden Campaign: www.wildones.org.

Glossary

Albedo:

Exterior surface reflectivity index, or the capacity of a surface to reflect back light as evaluated across a specified range of frequencies.

Biomass:

The standing dry weight of all vegetation, typically measured in kilograms per square meter.

Coefficient of Conservancy/Floristic Quality Assessment (FQA):

An ecological integrity evaluation tool for NPCs, pioneered by Wilhelm (1977) and later refined by Swink and Wilhelm (1979, 1994). Currently, all 50 states use FQA systems. All plants within a subject community are scored from 0–10, from most to least invasive (e.g., in Minnesota: common buckthorn *Rhamnus cathartica* = 0; pink and white ladyslipper orchid *Cypripedium reginae* = 10).

Cultivar or CV:

Named variety of a hybrid plant species e.g., Iris “Caeser’s Brother” is an Iris siberica crossed Iris sanguinea hybrid. CVs are generally more vulnerable to pest infestations and usually lack pollen or nectar in their flowers.

Ecosystem Provinces:

Major ecosystem zones with distinctive physical structures and groupings of plants (trees, shrubs, vines, herbaceous) with unique soil orders, precipitation, climate, and specific stochastic disturbance regimes, such as winds, fire, or floods.

Historical Context or European Presettlement:

Refers to native landcovers in Minnesota prior to 1840.

Tree Sizes:

Large, medium, and small refer to the ultimate mature dimensions of that tree species, not tree size at time of planting. For example, hybrid elm, burr oak, hackberry, American linden, white pine, etc. would be considered large trees.

Tree Species:

Primary taxonomic classification, ranking below genus.

Tree Genera:

Second-level of scientific species classification, (e.g., maples: Acer, oak: Quercus, elms: Ulmus are all tree genera). Note that as multiple species (cultivars) may be of the same genera; if multiple species or cultivars are selected for a site which belong to a single genera, only a single genera is represented by those selections.

Guideline S.5: Animal Habitat Support

Intent

To protect and support site animal habitat resilience by reducing the negative impact of the built environment on animal species and providing supportive environments for at-risk native species that are essential to ecosystem health.

Required Performance Criteria

Guidelines S.5A through S.F apply to all projects with new or renovated glazing within project scope. Other guidelines apply to all projects designated New Buildings and Major Renovations with site work site scope that includes an area of site disturbance that is greater than 3,000 s.f. OR Area of imperviousness (footprint of building plus site impervious area) renovated that is greater than 2,000 s.f..

A. Bird safety: Whole Building Threat Factor (WBTF)
   The WBTF must be less than or equal to WBTF 45 for sites not designated critical. The WBTF must be less than or equal to 15 for critical sites. The WBTF is calculated through the B3 Guidelines Bird-Safe Design Calculator (Appendix S-5a). This calculator will also assist in determining compliance with S.5B, S.5C, S.5D, and S.5I (if pursuing).
B. Bird safety: Non-Enclosure Threat Factor (NETF)
   The NETF must be less than or equal to 45. Use the B3 Guidelines Bird-Safe Design Calculator to determine NETF for non-enclosure surfaces.
C. Bird safety: High Risk Surfaces
   The portion of the building considered a High Risk Surface may not include a material with a threat factor of 75 or greater in more than 15% of its surface area. A High Risk Surface is defined as:
   1. Any condition that offers a view from exterior to exterior that is greater than 20 ft. across, such as a large atrium or glazed corners.
   2. A surface within 50 ft. or less of attractants such as trees, shrubs, prairie, grassland, or open water (including green roofs with this type of vegetation).
D. Bird safety: traps
   No portion of the building considered a trap may include any glazing with a threat factor (TF) greater than 25: For the purposes of these guidelines, the following conditions are considered traps:
   1. Transparent exterior railings where all surfaces are exposed to exterior.
   2. Transparent-sided walkways (e.g., skyways, covered walks with glass on two sides).
   3. Any condition that offers a view from exterior to exterior that is 20 ft. or less across, such as a small atrium or glazed corners.
E. Bird safety: Lights Out management procedure
   Follow the Lights Out light management program, which addresses operation of lights at night for specified times and dates of bird migrations. Note that this procedure is also required by law for state-owned and managed buildings. The program advises turning off building lighting including but not limited to: architectural lighting at top of building; uplighting; interior lighting, especially on upper floors; and lobby or atrium lighting during times and dates listed below.
   1. Dates: between March 15 and May 31 and between August 15 and October 31 each year.
   2. Times: between midnight and dawn.
   3. Exception: lights that have been documented as necessary for normal use of the building between midnight and dawn may be operated.

F. Bird safety: first-year monitoring

For one year after construction/occupancy, the perimeter of the building(s) should be walked and all accessible setbacks and roof areas observed at least twice per week. Activity and findings should be surveyed and documented as listed in Appendix S-5f Bird-Safe Monitoring Worksheets.

G. Protection of rare, threatened, or endangered species:

If the project site is within 2 miles of a Minnesota state rare, threatened, or endangered species, the project team must create and execute a Minnesota state rare, threatened, or endangered species protection plan for those species on the project site, in coordination with MBS staff at the DNR. This shall include the following:

1. A perimeter exclusion fence a minimum of 42 in. tall.
2. A permanent outdoor interpretive sign of dimensions greater than 24 in. by 36 in. that references the site's identified rare, threatened, or endangered species using Tilden's 5 Principles of Interpretation.
3. An O&M manual to vigorously protect species, with instructions on how to enhance the vigor of the subject species until delisting.
4. Supportive habitat for the noted species, aggregated into largest single units with least perimeter.
5. Management practices for the subject site designed to protect and enhance the viability of rare, threatened, or endangered species until that species is delisted. Requirements may include avoidance, buffers, management with fire, elimination of fertilizers and invasive species, and/or artificial drainage.

H. The following provisions for animal habitat should be included in design:

1. Water features with the following characteristics are required for all B3 sites subject to the listed exclusions:
   i. Open year-round (e.g., an aerator may be required to ensure that at least 10% of the water feature is accessible year-round).
   ii. Gently sloped (<10% grade) access for a 5-ft. horizontal distance.
   iii. Sites with limited ledges and sharp drop-offs.
   iv. For water features, the primary water source should be roof-collected rainwater, supplemented by treated greywater and potable water as necessary to maintain water feature.
   v. Water features are not required for sites within 500 ft. of an existing natural water body of at least 1 acre in size or a stream at least 10 ft. in width.
   vi. Size requirements as follows, for listed nonbuilding area:

Size of Site	Size of Water Feature (in Square Feet)	Maximum Depth of Feature (in Inches)	Size of Feature of Under 2" Depth (in Square Feet)	Percent of Perimeter with Gently Sloped (Under 10% Grade) Access
Less than 1 Acre	100	12	50	50%
1 to 3 Acres	300	12	100	50%
3 to 5 Acres	500	24	200	40%
5 to 10 Acres	2,000	24	200	30%
10 to 20 Acres	8,000	36	1000	30%
20 to 40 Acres	16,000	n/a	2000	30%
More than 40 Acres	15% of site area	n/a	15% of water feature area	20%

2. If the project site is either greater than 3 acres in size or if the site is adjacent to or adjoining a permanent surface water body, natural bat habitat enhancement should be installed and maintained, including implementation of the following:
    i. Multiple standing snags (>10" DBH) and downed logs in all wooded areas of subject site.
    ii. Bat boxes to provide roosting area for 80 colony roosting bats per acre of surface water and 40 colony roosting bats per acre of nonsurface water areas.
    iii. Bat boxes within 100 ft. of permanent site water feature, facing south or southeast.
    iv. During the fifth growing season following project opening, the number of bats on subject site should be observed and recorded. Bat habitat should be remediated if at least 50% of the bat boxes have not been used by at least one species of bat that season.
3. Reptile and amphibian habitat and breeding sites should be created with natural and human-made structures to achieve at least one amphibian and one reptile by the fifth growing season. Provide acceptable reptile and amphibian enhancement structures on a year-round basis, including implementation of the following:
    i. Natural options: standing snags, brush piles, piles of leaf litter, downed log, haul-out logs in water bodies, large flat sunning stones in full sun, wood and rock mulches, sand and gravel baths on south slopes and in shallow water.
    ii. Human-made options: stone snake or reptile hibernaculum; fabricated buried wood, stone or concrete reptile and amphibian dens; submerged Christmas tree reefs; wooden stream-bank lunkers.
    iii. Any other reptile and amphibian habitat enhancement structures may be acceptable if they have been listed in peer-reviewed literature and approved by the B3 Guidelines Team.
    iv. Limiting area of mown lawn to increase available reptile and amphibian habitat.
    v. Avoiding use of pesticides that harm animals.
    vi. Verifying the presence of reptile and amphibians during the fifth growing season following the project opening and during the monitoring period of March to November, for a period not to exceed 24 hours. A 48-hour bio-blast monitoring protocol is an acceptable methodology. Animals may be captured for monitoring purposes only, but limit time of handling to avoid stressing, injuring, or killing these temporarily captured animals. Remediate reptile and amphibian habitat if at least one reptile and one amphibian have not been observed.
4. Insect pollinator habitat should be created so that during the fifth growing season following the project opening, at least one butterfly, one bee, and one other insect pollinator shall be found on site using monitoring protocols during a 24-hour search. The site design should be remediated as necessary to achieve this if insect pollinators are not found during monitoring.

I. The aggregate illumination level outlined under the most recent International Dark-Sky Association (IDA) IES Model Lighting Ordinance (MLO) should not be exceeded for the project's lighting zone.

Recommended Performance Criteria

J. A WBTF of less than or equal to 15 (see S.5A for more details).

K. Enhanced bird-safe building monitoring, implementing one or more of the following:
1. Continued monitoring performed under S.5F by one or more additional years.
2. More surveys per week for the first or more years.
3. Ongoing work with an organization such as Audubon Minnesota to collect and catalog birds found.

L. Bird-safe lighting design.
   1. Lighting levels listed below are not exceeded for the listed environmental lighting zone.[35]

Environmental Lighting Zone	Description	Maximum Vertical Illuminance Levels [fc] at Property Line	Achieve the Following Light Distribution Characteristics
E1: Intrinsically Dark	Parks and residential areas where controlling light pollution is a high priority	0.1	Use luminaires with light distribution that meets IES's Full Cutoff Fixtures.
E2: Low Ambient Brightness	Outer urban and rural residential areas	0.1	Use luminaires with light distribution that meets IES's Cutoff Fixtures.
E3: Medium Ambient Brightness	Urban residential areas	0.2	Use luminaires with light distribution that meets IES's Semi-Cutoff Fixtures.
E4: High Ambient Brightness	Urban areas having both residential and commercial use and experiencing high levels of nighttime activity	0.6	Use luminaires with light distribution that meets IES's Cutoff Fixtures.

      i. For façade, display, sculptural, and sign lighting:
         (1) For luminaires of 3500 or more lumens, objects lit from above.
         (2) For luminaires of less than 3500 lumens, objects may be lit from below. An effort is made to minimize non-target light (and to maximize the percentage of uplight that falls on the target).
   2. Create lighting control zones and provide lighting control devices for parking lot, security, and decorative and façade lighting so that each type of lighting can be controlled independently and can be turned off or reduced in response to reduced lighting needs during low use or nonuse periods. Clearly relate decisions to the Lights Out program.
   3. Document bird-safe lighting design measures undertaken.

M. Bird-safe building narrative: A Bird-Safe Case Study Narrative Report documents and shares bird-safe efforts. (Use Appendix S-5m Bird-Safe Building Narrative Template or include a writeup with similar content.)

N. Limited use of pesticides site-wide, specifically eliminated within 300 ft. of the site's required permanent water feature and all other surface waters within 1,000 ft. of the site.

Meeting the Guidelines

In Predesign and early design, the impact of glazing percentage on bird safety should be considered and evaluated. If the building use is likely to be associated with large glazed areas, consider if increased risk/adjustments are needed on highly vegetated sites. Additionally, an ecological assessment of the site that includes an evaluation of bird species, habitat, and migration patterns should be considered.

[35] Adapted from Illuminating Engineering Society of North America (IES) RP-33-99, using “post curfew” recommendations for all values to ensure that light trespass is minimized for each environmental zone.

Through the design process, identify attractant areas for birds on the site, plan deterrents for facades adjacent to attractants, and keep glazed areas of buildings greater than 50 ft. away from attractants. Configure building to minimize bird collision traps. Traps can include clear barriers, transparent railings, or other glazed see-through conditions. See guideline for complete conditions deemed to be traps.

Early designs should be evaluated with the Bird-Safe Calculator (Appendix S-5a) and designs should be adjusted to meet bird-safe criteria. Design should be checked against bird-safe criteria and the WBTF in the Bird-Safe Building Calculator update to confirm continued compliance.

As the construction documents are developed, continued compliance with all required and pursued recommended bird-safe criteria should be confirmed, adjusting documentation and design as needed.

Contract documents should include those features needed for bird-safe compliance, as calculated using the Bird-Safe Calculator (Appendix S-5a). Bidders should be made aware of specific requirements for sustainable construction according to the B3 Guidelines. Substitutions that would change the bird-safe performance of the building should be monitored, and any material substitutions should meet bird-safe performance criteria. Correct implementation of features affecting bird-safe performance should confirmed according to drawings and specifications. Bird-safe first-year monitoring and Lights Out program criteria should also be implemented in the project documentation. A lighting engineer should be consulted regarding controls for lights to accommodate Lights Out program compliance.

Required first-year bird-safe monitoring should be performed, as should any recommended ongoing monitoring that was pursued, using Appendix S-5f for First-Year Building Monitoring. If pursuing Bird-Safe Case Study Narrative, coordinate with lighting engineer on documentation of lighting benefits anticipated from Lights Out program. Documentation of recommended bird-safe lighting design under S.5L Bird-Safe Lighting Design should also be considered.

Prior to any physical site activities including inspections, disturbance, or mobilization of the project site, the relevant DNR, Minnesota Heritage Division, CBS maps should be consulted to determine if there are any Minnesota state rare, threatened, or endangered species within 3 miles of the subject site. Minnesota state rare, threatened, or endangered species symbols are typically identified as ◊ animal or * plant on the CBS maps.

If a Minnesota state rare, threatened, or endangered species is located within 5 miles of the project site, staff at the MBS of the DNR should be determine the subject site's distance adjacency to a Minnesota state rare, threatened, or endangered species. If MBS DNR determines that the subject site is within 2 miles of a Minnesota state rare, threatened, or endangered species, the project team should be notified and informed of which plant or animal species is the Minnesota state rare, threatened, or endangered species. The project is then required to create a Minnesota state rare, threatened, or endangered species protection plan for those species on the subject site, in coordination with MBS staff at the DNR.

If bat boxes are required due to the site condition per guidelines, required bat boxes should be located so that the largest surface of the bat box has a south, west, or southeast aspect during the growing season (April–October), so that sun exposure on the bat box is a minimum of six hours per day. Bat boxes should not be mounted in shade and should be seasonally mounted and ready for use by bats no later than April 1. Bat boxes should be located on solid structures with a minimum of a 30-ft. distance from trees (do not mount on poles or trees, and do not mount on or adjacent to windmills). The bottom of bat box should be elevated a minimum of 15 ft. above the ground or at least 12 ft. above the top of nearest vegetation. Bat boxes should be sheltered from prevailing winds during the growing season. They should not be illuminated from above or below. They should not be located immediately above an asphalt road or parking lot. Fabricate larger (>24 in. x >24 in. x 8 in.) bat boxes from natural, dark colored untreated wood with rough surfaces throughout (cedar, cypress, redwood, juniper). Do not use polished or planed surfaces in the construction of bat boxes,

and do not attach wires or hardware mesh. Do not paint interiors or exteriors of bat boxes. Use closely spaced (~1/2 in.) multi-chambered bat boxes accessed by bats from below (see Bats Conservation International guidance). Provide a vertical landing pad immediately beneath bat box access point. Use black roofing, maintain waterproofing throughout, and tightly seal. Thoroughly caulk all site buildings adjacent to bat boxes to close openings smaller than a dime to eliminate accidental bat infestation. At year five, post-occupancy, monitor bat boxes to ensure at least 50% of bat boxes are occupied with bats. Report any incidences of white-nose syndrome on bats to DNR Nongame Wildlife. Clean bat boxes annually per Bat Conservation International bat box maintenance guidelines.

Insect-pollinated trees, shrubs, vines, and groundcovers which may be used to create insect pollinator habitats include:

- Spring and summer: cherries, plums, peaches (Prunus spp.), apples, crabapples (Malus spp.), pears (Pyrus spp.), persimmon (Diospyros spp.), hawthorns (Craetagus spp.), serviceberries (Amelanchier spp.), nannyberries (Viburnum spp.), honeysuckle (Lonicera spp.), holly (Ilex spp.), linden (Tilia spp.), catalpa (Catalpa spp.), dogwoods (Cornus spp.), willows (Salix spp.), redbud (Cercis spp.), hackberries (Celtis spp.), locusts (Gleditsia and Robinia spp.), elderberries (Sambucus spp.), magnolia (Magnolia spp.), tupelo (Nyssa spp.), tulip tree (Liriodendron spp.), horse chestnut (Aesculus spp.), hop tree (Ptelea spp.), mountain ash (Sorbus spp.), golden rain tree (Koelreuteria spp.), pagoda tree (Sophora/Styphnolobium spp.), silverbell (Halesia spp.), buttonbush (Cephalanthus spp.), New Jersey tea (Ceanothus spp.), lead plant (Amorpha spp.), grape vine (Vitis spp.), kiwi fruit (Actinidia spp.), trumpet creeper (Campsis spp.), raspberries (Rubus spp.), roses (Rosa spp.), blueberries, cranberries (Vaccinium spp.), strawberries (Fragaria spp.), prickly pear cactus (Opuntia spp.), stonecrop (Sedum spp.).

Insect-pollinated herbaceous perennials which may be used to create insect pollinator habitat include:

- Spring: lupine (Lupinus spp.), bloodroot (Sanguinaria spp.), buttercups (Ranunculus spp.), Dutchman's breeches (Dicentra spp.), columbine (Aquilegia spp.), Virginia bluebells (Mertensia spp.), spiderwort (Tradescantia spp.), lobelias (Lobelia spp.), golden alexanders (Zizia spp.).
- Summer: prairie clovers (Petalostemum spp.), milkweed (Asclepius spp.), wild bergamot (Monarda spp.), giant hysopp (Agastache spp.), beard tongue (Penstemon spp.), bush clovers (Lespedeza spp.), Canada milk-vetch (Astragalus spp.), Culver's root (Veronicastrum spp.), evening primrose (Oenothera spp.), ironweed (Vernonia spp.), false indigo bush (Baptisia spp.), tickseed (Coreopsis spp.), Canada tick trefoil (Desmodium spp.), obedient plant (Physostegia spp.), mountain mint (Pycnanthemum spp.), partridge pea (Chamaecrista spp.), yellow coneflower (Rudbeckia spp.), cup plant (Silphium spp.), Joe Pye weed (Eupatorium/Eutrochium spp.), blazing stars (Liatris spp.).
- Fall: asters (Aster spp.), sneezeweed (Helenium spp.), gentian (Gentian spp.), boneset (Eupatorium spp.), goldenrods (Solidago spp.), sunflowers (Helianthus spp.).

The lighting zone for the project can be determined by referencing the Joint IDA IES MLO dated June 15, 2011. Lighting zones include the following:

- LZ-0: No ambient lighting
- LZ-1: Low ambient lighting, or for other uses
- LZ-2: Moderate ambient lighting

The determination of the lighting zone and the calculated total site lumens for the site should be recorded. Site lighting requirements should be designed in accordance with the performance method allowed for the lighting zone and a project site plan submitted complying with the total site lumens for the selected light zone.

Submittal Requirements

Predesign:

- S.5G: Submit DNR, Minnesota Heritage Division, CBS maps showing the boundary limits of subject site and the surrounding 5-mile distance in miles to nearest Minnesota rare, threatened, or endangered species. If dimensions show a Minnesota rare, threatened, or endangered species within 3 miles of subject site boundaries, obtain and submit a MBS determination on DNR letterhead of whether these species are at a distance less than 2 miles of the project site. If dimensions show a rare, threatened, or endangered species within a distance less than 2 miles of subject site boundaries based on MBS determination, obtain and submit a letter of cooperation from MBS staff to produce a joint rare, threatened or endangered species protection plan on dated DNR letterhead.

Design:

- S.5A (and S.5I if pursuing): Submit WBTF (as calculated by Appendix S-5a), and preliminary version of Appendix S-5a.
- S.5B: Submit NETF (as calculated by Appendix S-5a), and upload of preliminary version of Appendix S-5a.
- S.5C: If the project includes new High Risk Surfaces, note that the area of that surface with a TF greater than 75 is less than guideline limits, and preliminary version of Appendix S-5a.
- S.5D: Submit traps TF (as calculated by Appendix S-5a), and upload preliminary version of Appendix S-5a.
- S.5G: If it has been determined that the project requirements are triggered for the protection of rare, threatened, or endangered species, include preliminary specification sections referencing design and installation of a perimeter exclusion fence a minimum of 42 in. tall and a permanent outdoor interpretive sign per guideline requirements. Also submit a joint rare, threatened, and/or endangered species protection plan cosigned by MBS staff on dated DNR letterhead, including details and specifications for site preparation (weed and erosion control), site drainage, and revegetation (seeding, planting, etc.) for this specialized NPC based on MBS DNR staff guidelines.
- S.5H: Submit preliminary site plan outlining guide requirements, including water feature, bat habitat, reptile and amphibian habitat, and pollinator habitat.
- S.K: Lighting zone that most represents the surround site conditions of the project site and identified anticipated aggregate illumination level.

Final Design:

- S.5A (and S.5I if pursuing): Submit WBTF (as calculated by Appendix S-5a), and final version of Appendix S-5a.
- S.5B: Submit NETF (as calculated by Appendix S-5a), and upload final version of Appendix S-5a.
- S.5C: If the project includes new High Risk Surfaces note that the area of that surface with a TF greater than 75 is less than guideline limits, and final version of Appendix S-5a.
- S.5D: Submit traps TF (as calculated by Appendix S-5a), and upload final version of Appendix S-5a.
- S.5G: If it has been determined that the project requirements are triggered for the protection of rare, threatened, or endangered species, include final specification sections referencing design and installation of a perimeter exclusion fence a minimum of 42 in. tall and a permanent outdoor interpretive sign per guideline requirements. Also submit a joint rare, threatened and/or endangered species protection plan cosigned by DNR MBS staff on dated DNR letterhead, including details and specifications for site preparation (weed and erosion control), site drainage, and revegetation (seeding, planting, etc.) for this specialized NPC based on MBS DNR staff guidelines and updated as needed from the design phase submission and incorporating all guidelines requirements.

- S.5L: Submit site plan outlining designed light levels demonstrating compliance with the guideline limits. Include narrative of lighting design and lighting control zones.
- S.5M: Submit Bird-Safe Case Study Narrative Report based on Appendix S-5m or using similar content.

Closeout:

- S.5A (and S.5I if pursuing): Ensure WBTF of installed condition meets guideline limits (as calculated by Appendix S-5a) and Appendix S-5a, updated as needed.
- S.5B: Submit NETF of installed condition (as calculated by Appendix S-5a), and upload final version of Appendix S-5a, updated as needed.
- S.5C: If the project includes new High Risk Surfaces, note that the area of that surface of installed condition with a TF greater than 75 is less than guideline limits and Appendix S-5a, update this as needed to reflect installed condition.
- S.5D: Traps TF of installed condition (as calculated by Appendix S-5a), and Appendix S-5a, updated as needed.
- S.5E: Verification of a Lights Out management program in place.
- S.5F: Verification that the facility operations team is aware of first-year monitoring requirements.
- S.K: Lighting zone that most represents the surrounding site conditions and designed aggregate illumination level.

Occupancy – Submitted annually for ten years:

- S.5E: Verification of adherence to Lights Out management program.
- S.5F: (Year one only): Verification of first-year monitoring.
- S.5J: Documentation of enhanced bird-safe building monitoring.
- S.5H: Annual inventory, condition, and recovery rate of endangered species. At year five submit inventory of bat, reptile and amphibian, and pollinated populations to meet required performance criteria. Ensure at least 50% of bat boxes are occupied with bats. Remediate habitat if requirements are not met. Report any incidences of white-nose syndrome on bats to DNR Nongame Wildlife.
- S.5M: Documentation of operations pesticide limits and methods of ensuring compliance.

Additional Resources

Appendix S-5a Bird-Safe Calculator

Appendix S-5f Bird-Safe Monitoring Worksheets

Appendix S-5m Bird-Safe Case Study Narrative Template

Bat Conservation International (BCI): http://www.batcon.org/.

Bird-Safe Building Guidelines by Audubon Minnesota and Project Birdsafe: http://mn.audubon.org/conservation/birdsafe-buildings.

Henderson, Carrol. 2010. *Woodworking for Wildlife*. Minnesota: MN DNR.

Henderson, Carrol. 1987. *Landscaping for Wildlife*. Minnesota: MN DNR.

Holm, Heather. 2014. *Pollinators of Native Plants: Attract, Observe, and Identify Pollinators and Beneficial Insects with Native Plants*. Minnesota: Pollination Press.

International Dark-Sky Association (IDA): www.darksky.org, International Dark-Sky Association Joint IDA IES Model Lighting Ordinance: http://www.darksky.org/wp-content/uploads/bsk-pdf-manager/16_MLO_FINAL_JUNE2011.PDF, Recommended Lighting Zones: http://www.darksky.org/lighting/model-lighting-laws-policy/recommended-lighting-

zones/, IDA Mapping Earth's Night One Picture at a Time: http://www.darksky.org/mapping-earths-night-one-picture-at-a-time/.

MN DNR, Ecological Classification System (select applicable ecosystem provinces, sections, subsection to download the complete plant lists): http://www.dnr.state.mn.us/ecs/index.html.

MN DNR, CBS Maps of Minnesota: http://www.dnr.state.mn.us/eco/mcbs/maps.html.

MN DNR, Invasive Species: http://dnr.state.mn.us/invasives/terrestrialplants/index.html.

MN DNR Pollinator BMPs and Habitat Restoration Guidelines: http://files.dnr.state.mn.us/natural_resources/npc/2014_draft_pollinator_bmp_guidelines.pdf.

Minnesota County Biological Survey: www.dnr.state.mn.us/mbs/index.html.

Pollinator Garden: About Plants, Pollinating Insects and Gardening: http: www.foxleas.com.

Sheppard, C. 2011. *Bird-Friendly Building Design*. American Bird Conservancy, The Plains, VA: http://collisions.abcbirds.org/.

State of Minnesota Lights Out Management Program: http://www.revisor.leg.state.mn.us/laws/?id=101&doctype=Chapter&year=2009&type=0.

United States Dept. of Agriculture, Natural Resources Conservation Service, Engineering Field Handbook: https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21429.

UMN Bee Lab "Plants for Minnesota Bees": https://www.beelab.umn.edu/sites/beelab.umn.edu/files/plants_mn_bees.pdf.

Xerces Society Pollinator Conservation: http://xerces.org/pollinator-conservation/.

Glossary

Brush Piles:

Pile of topped or broken branches on the ground promoting insect-feeding bird habitat.

Tree Snag:

A standing dead or dying tree often missing a top or most of the smaller branches, promoting insect-feeding bird habitat.

Gravel/Sand Baths:

A shallow depression filled with evenly graded sand or gravel, above the toe of the slope to aid birds and small mammals in parasite removal.

Terraclium/Hibernaculum:

Shelter occupied during winter by a cold-blooded dormant animal.

Christmas Tree Reefs:

Human-made underwater structure build to promote aquatic habitat.

Beaver Deceiver:

Trapezoid protective fence upstream of pipe to eliminate beaver damming.

Stream-Bank Lunkers:

Three-sided, open framed, wooden fish crib installed directly into stream banks, anchored with steel rods, stone slabs and earth to create artificial cut bank for fish shelter/protection.

Downed Tree Log:

A length of trunk or large limb of felled tree to promote insect-feeding bird habitat and discourage unregulated mountain biking.

Threat Factor (TF):

Threat factor (TF), a property of a building material related to likelihood of bird collision, found in the TF Table (See Appendix S-5a). Consult the B3 Guidelines Team if you have questions on what TF should be used for a material.

Traps:

Traps are glazed conditions that are particularly likely to produce bird strikes. These are defined in the B3 Guidelines as any of the following: Transparent exterior railings (e.g., a glass or plexiglass panel in an exterior railing system), transparent-sided walkways (e.g., skyways with both sides glazed, covered walks with glazing on both sides), or any other condition where multiple transparent or translucent surfaces on the exterior of the project are separated by 20 ft. or less and which can be seen through simultaneously (e.g., a small atrium, or glazed corners).

High Risk Surfaces:

High Risk Surfaces are those surfaces within 50 ft. or less of attractants such as trees, shrubs, prairie, grassland, or open water, or any other condition where multiple transparent or translucent surfaces on the exterior of the project are separated by 20 ft. or more and which can be seen through simultaneously (e.g., a small atrium or glazed corners).

Permanent Surface Water Body:

Lake, pond, river, creek, stormwater pond.

Solitary/Mason Bees:

Provide untreated wooden drilled blocks with holes diameter ranging from 2–10 mm x 80–100 mm deep. Provide waterproof roof and mount on solid surface 48 in. (1,200 mm.) above ground. Replace blocks every 2 years.

Critical Sites:

For sites that include development of prime farmland, farmland of state significance, former municipal, township or county parkland, formerly federally protected lands, or that are on areas covered by a conservation easement, or that are on areas under a conservation easement, the only allowed activity is restoration to the original NPC, per the Minnesota CBS.

Material and Waste Guidelines

Intent

To reduce embodied environmental impact and toxicity in the building materials.

Which products relate to which guidelines?

Different products contribute to compliance in different guideline categories. The table below lists which guidelines are related to only *interior materials* and which guidelines may be met using any product selected for the project. This includes Guideline I.1 as it relates to product selection.

	I.1: Low Emitting Materials	M.1B: Product Life Cycle Assessments	M.1: Environmentally Preferable Materials	M.4: Health
Interior Materials (see definition under I.1)	All interior materials in project must comply with I.1			10 materials required (if one of most common it may be double counted)
Any Materials in Project		5 materials required, may be any used in project	55% of all materials are required, some may contribute in multiple categories, so actual % of contributing materials may be lower	

General Material Information:

The following information is collected in the Materials section of the B3 Guidelines Tracking Tool, under Section M.0:

Final Design:

- Material strategies used, including narrative.

Guideline M.1: Life Cycle Assessment

Intent

To use life cycle analysis to quantify and minimize the environmental impact of building materials, which have significant effects on global warming, air pollution, water pollution, energy consumption, and waste.

Required Performance Criteria

Guidelines apply to all projects designated New Buildings and for Major Renovations. M1A is not required for renovation buildings or portions of buildings. M1A is required for all additions over 20,000 square feet and additions that are greater than or equal to 20% of a preexisting building's floor area.

A. Whole-Building Life Cycle Assessment (LCA):
Demonstrate a reduction in life cycle Global Warming Potential (GWP) of the building's construction materials through building massing, structural design, dematerialization, and alternative assembly and material selection. This credit shall be met by documenting GWP reduction using one of the three listed compliance paths and by using one of the approved whole-building LCA software tools to complete a whole-building LCA model. A whole-building LCA model representing the final design of the project is required regardless of the chosen GWP reduction compliance path.

1. GWP Reduction Documentation Paths:
    i. GWP Reduction Path 1: Whole-Building LCA Approach
    This path may be used for any building scenario and will provide a basis for comparing the impact-reduction strategies with the most potential. These include whole-building strategies such as changes to the building plan to optimize shape, layout, and surface area of assemblies. Impacts from assembly and material selections may also be documented by using this path.
    Following this path, use whole-building LCA models to document a 10% reduction in GWP. The basis for this reduction is a comparison between the Selected Building Design (the design of the building at the end of the CD phase, representing the final design of the building) and the Reference Building, developed by the end of the SD phase and updated as needed. There are several methods for creating the Reference Building discussed in more detail below.[36]
    ii. GWP Reduction Path 2: Assembly-Level LCA Approach
    This path requires the utilization of an LCA model of a representative portion of the building to document a 10% reduction in GWP. This approach is fundamentally similar to Path 1, but a smaller functional unit based on structural bays or another representative unit is modeled in lieu of the whole-building. The basis for this 10% reduction is a comparison between the Selected Design - Partial (the final design of the selected structural bays) to the Reference Model - Partial, developed by the end of the SD phase and updated as needed.
    This compliance path provides a basis for comparing assembly-level and material-level impact reduction strategies but cannot be used with building-level strategies such as massing and layout. Projects using this path must also complete and submit a whole-building LCA model at the completion of design.

[36] This compliance path closely follows the requirements of USGBC, "Materials and Resources Credit: Building Life-Cycle Impact Reduction," *LEED Building Design and Construction v.4*, with several key changes.

iii. GWP Reduction Path 3: Material-Level LCA Approach

Use the B3 LCA Material Selection Calculator to document that the building's primary construction materials achieve an Impact Score of 1.6 or less.

This compliance path may be used when the design team is only evaluating material substitutions to reduce GWP (e.g., exchanging one type of cladding for another). It does not compare impacts of broader building-level or assembly-level impact reduction strategies. This compliance path is limited to building projects that utilize one dominant structural and enclosure type, which must make up at least 60% of the building's structural volume and exterior surface area respectively. This compliance path is additionally limited to projects utilizing assemblies and materials that are well approximated by the assemblies and materials contained in the B3 LCA Material Selection Calculator. Projects using this path must also complete and submit a whole-building LCA model at the completion of design.

2. Whole-Building LCA Model:

This LCA building model must be completed using one of Approved Whole-Building LCA Software Tools. It should be submitted at the end of the CD phase and represent the final design of the building. If Path 1, Whole-Building LCA Approach was selected to document GWP reduction, the Selected Building Design LCA model from that approach fulfills this requirement. Whole-Building LCA models must follow the requirements as listed in Meeting the Guidelines: M.1A section below.

B. Product Life-Cycle Assessments[37]

Use at least 5 different permanently installed products sourced from at least five different manufacturers that meet one of the disclosure criteria below:

1. Product-specific declaration.
   i. Products with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that report impacts from at least cradle to gate.
2. Environmental Product Declarations (EPD) which conform to ISO 14025, 14040, 14044, and EN 15804 or ISO 21930 and have at least a cradle-to-gate scope.
   i. Industry-wide (generic) EPD – Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator are valued as one-half (½) of a product for purposes of compliance.
   ii. Product-specific Type III EPD – Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as the participant by the program operator are valued as one whole product for purposes of compliance.

Meeting the Guidelines: M1A

Approved Whole-Building LCA Software Tools

- Tally
- Athena Impact Estimator
- For other methods, please contact guidelines@b3mn.org to request evaluation of additional methods of whole-building LCA evaluation. This list will be updated if other methods are approved.

[37] This guideline is aligned with the International Green Construction Code and ANSI/ASHRAE/USGBC/IES Standard 189.1, "9.4.1.4 Multiple-Attribute Product Declaration or Certification," some language also shared with LEED v.4.

Allowable GWP Impact Reduction Strategies by Path.

The strategies that can be used to reduce environmental impacts vary by path; below is a summary of the options available under the three compliance paths:

Impact Reduction Strategies	Path 1 Whole-Building	Path 2 Assembly Level	Path 3 Material Level
Building size (floor area)	no	no	no
Building service life	no	no	no
Building shape (layout, surface area)	yes	no	no
Building structural spacing (grid layout)	yes	no	no
Assembly substitutions (swap types)	yes	yes	no
Assembly design changes (thicknesses and layers of materials)	yes	yes	no
Window-to-wall area ratio changes	yes	yes	no
Floor-to-floor height changes	yes	yes	no
Structure design changes (type and sizing of beams + columns)	yes	yes	no
Material substitutions	yes	yes	yes

Whole-Building LCA Model Requirements:

Requirements of the whole-building LCA model:[38]

1. Building service life shall be 60 years.
2. The scope of the assessment must include EN15978 Phases A1–A5, B1–B5, and C1–C4 (cradle to grave) but omit phase D (beyond building life). Building operational energy and water use (Phases B6, B7) are not included for this requirement though both the Selected Building Design and the Reference Building must meet current B3 and SB 2030 requirements.
3. The LCA models must include the complete building enclosure from the interior to the exterior layer, structural elements (posts, beams, bearing walls), including the intermediate floors and foundation and any attached parking structures.
4. All interior finishes shall be omitted with the exception of those on exterior above and below grade walls.
5. The LCA models should omit electrical and mechanical equipment including elevators, pipes, plumbing fixtures, and control systems, as well as items exterior to the building such as landscaping and surface parking lots.
6. The Selected Building Design and Reference Building must be functionally equivalent. They must serve the same program, same gross floor area, and the same operational energy and water efficiency. The operational energy and water use for both the Selected Building Design and the Reference Building must meet current B3/SB 2030 requirements.[39]

[38] These whole-building LCA requirements are aligned in part on USGBC, "Materials and Resources Credit: Building Life-Cycle Impact Reduction," *LEED Building Design and Construction v.4*, with some changes noted.
[39] Differs from LEED v.4 credit: Interior non-structural walls and assemblies should be omitted from the LCA models.

GWP Reduction Documentation Options:

Documenting a 10% GWP reduction for a building's construction materials often requires early-phase design changes, which necessitate a start to LCA evaluation in the schematic design phase. Substantial changes to a building's structure, envelope, or building plan may be necessary. This often requires coordination between multiple team members – architects, structural engineers, and building owners.

GWP Reduction Path 1 – Whole-Building LCA Approach[40]

Defining the Reference Building:

The Reference Building LCA model should be completed early in the SD phase so it can be used as a benchmark for comparing design cases and gauging GWP reductions. For Path 1, the total area of exterior walls, floors, and roofs may differ between the Reference Building and the design cases to account for optimization in building shape, layout, and surface area. The Reference Building and Selected Building Design must remain functionally equivalent, with equal floor area and space use types. Water and energy consumption must be approximately equal and meet current SB 2030 standards.

There are a variety of valid approaches for defining the Reference Building.[41] The design team performing the LCA analysis may choose from the following options to best meet their needs:

1. Early design case – an early design for the building under study.
2. Existing building – a real-world benchmark, modified to match the floor area and energy efficiency of the project.
3. Building archetype – a design similar to an existing building modified to match the floor area and energy efficiency of the project.
4. Alternative design – a design based on the project design but that is more reflective of industry-standard materials and practices.

GWP Reduction Path 2 – Assembly-Level LCA Approach

The functional unit used in this path to document GWP reduction is a representative slice through the building incorporating the most common construction assemblies. It must extend from exterior wall to the opposite exterior wall and from the foundation to the roof. For buildings with structural bays this should incorporate at least two bays. For buildings without structural bays, project teams should contact B3 Guidelines Support to ask for guidance on selecting and sizing an appropriate functional unit for modeling. All applicable whole-building LCA modeling requirements (as listed in Meeting the Guidelines Part 1a–g) should be applied to the LCA models.

GWP Reduction Path 3 – Material-Level LCA Approach

To use this path, the building design and design team must comply with the following requirements.

1. The project must have one dominant structural and enclosure type, comprising at least 60% of the building's structural volume and exterior surface area respectively.
2. This method only documents GWP reductions from material substitutions.

[40] Differs from LEED v.4 credit: for compliance with this requirement (M.1a), a 10% reduction is required for GWP only. Impacts in other environmental indicator categories such as eutrophication potential and acidification potential should be monitored, but performance improvements are not required in those areas. Compliance options 1, 2, and 3 of USGBC, "Materials and Resources Credit: Building Life-Cycle Impact Reduction," *LEED Building Design and Construction v.4* will not be considered as a compliance paths for this credit.

[41] Reference Building options and descriptions follow LEED v.4 credit requirements.

3. The building project is limited to the selection of materials that are well approximated by the assemblies and materials contained in the Path 3 B3 LCA Material Selection Calculator.

Using B3 LCA Material Selection Calculator:

The calculator contains a database with GWP impacts for ten different categories of material, such as cladding and roofing. Only one material type may be selected per category, and it must make up 60% or more of the material used by the building in that category (i.e., it must be the primary material type). If a building does not contain material in a particular category, that category must be entered as NA.

Within the calculator's database, specific materials are ranked by their GWP impact. The lowest GWP materials are assigned a material Impact Score group number of 1 or 2. Materials with medium GWP impact are assigned a material Impact Score of 3. High GWP materials are assigned a material Impact Score of 4 or 5. The building's Impact Score (averaged) across all categories must be 1.6 or lower to achieve compliance using this documentation path. If the building's Impact Score is greater than 1.6, Paths 1 and 2 may be used instead to allow the design team more flexibility to apply additional impact reduction strategies not available under Path 3. A series of graphs comparing the GWP impact of functionally equivalent building materials is provided to assist the practitioner in selecting materials that will help achieve compliance. These may be useful for guiding structure and envelope decisions in the early design phases.

Submittal Requirements: M.1A

Design:

- M.1A: Documentation of either Path 1, Path 2 or Path 3

  GWP Reduction Path 1 – Whole-Building LCA Approach

  - Upload the Reference Building LCA model and selected reports showing GWP impact. These reports should show impacts for life-cycle phases A–C only and must include total whole-building GWP impact as well as a breakdown of GWP by assembly type. Total GWP for the Reference Building must also be input separately.
  - Upload an iteration of the whole-building LCA model and reports that show reduction in GWP impact compared to the submitted Reference Building LCA model. Total GWP reduction must also be input into the Tracking Tool.
  - Required submittal files for Athena users:
    - Athena IE base files (Reference Building and current design iteration)
    - Reports: "Detailed LCA Results by Assembly Group Embodied Effects" in table format (reports for both Reference Building and current design iteration)
  - Required submittal files for Tally users:
    - Revit model files with included Tally specifications (Reference Building and current design iteration)
    - Reports: "Full Building Summary" (reports for both Reference Building and current design iteration)

  GWP Reduction Path 2 – Assembly-level LCA Approach

  - Upload the Reference Model structural bay model (Athena IE or Tally) and selected reports showing GWP impact. These reports should show impacts for life cycle phases A–C only, and must include total whole-building GWP impact as well as a breakdown of GWP by assembly type. Total GWP for the Reference Model must also be input into the Tracking Tool.

- Upload an iteration of the structural bay model (Athena IE or Tally) and reports that show reduction in GWP impact compared to the submitted Reference Model structural bay model. Total GWP for this model iteration must also be input separately.
- Required submittal files for Athena users:
  - Athena IE base files (Reference Model and current model iteration).
  - Reports: "Detailed LCA Results by Assembly Group Embodied Effects" in table format (reports for both Reference Case and current model iteration).
- Required submittal files for Tally users:
  - Revit model files with included Tally specifications (Reference Model and current model iteration)
  - Reports: "Full Building Summary" (reports for both Reference Model and current model iteration)

GWP Reduction Path 3 – Material-Level LCA Approach

- Upload a preliminary version of the completed Path 3 Compliance Calculator demonstrating selection of compliant assemblies. The Impact Score computed by the calculator must be 1.6 or lower to achieve compliance. Also input the Impact Score to the Tracking Tool.

Final Design:

- M.1A: Whole-Building LCA Model and Documentation of either Path 1, Path 2 or Path 3

Whole-Building LCA Model

- Regardless of the compliance path chosen, all projects must upload a final whole-building LCA model and selected reports showing GWP impact at the end of the construction documents (CD) phase. These reports should show impacts for life cycle phases A–C only, and must include total whole-building GWP impact as well as a breakdown of GWP by assembly type. The model should represent the closest available approximation of the building as it will be built. If the design team selected GWP Reduction Path 1 to demonstrate compliance, the final Selected Building Design LCA model satisfies this requirement.

GWP Reduction Path 1 – Whole-Building LCA Approach

- If there has been changes to the Owner's Project Requirements (OPR) (established in P1), confirm that the Reference Building model uploaded at the end of the Design phase still meets the updated OPR. If not, the Reference Building model may need to be updated.
- Upload the final Selected Design whole-building model and reports that show 10% reduction in total building GWP impact compared to the submitted Reference Building. The Selected Building Design should represent the closest available approximation of the building as it will be built.
- Required submittal files for Athena users:
  - Athena IE base files (Reference Building and Selected Building Design)
  - Reports: "Detailed LCA Results by Assembly Group Embodied Effects" in table format (reports for both Reference Building and Selected Building Design)
- Required submittal files for Tally users:
  - Revit model files with included Tally specifications (Reference Building and Selected Building Design)
  - Reports: "Full Building Summary" (reports for both Reference Building and Selected Building Design)

GWP Reduction Path 2 – Assembly-Level LCA Approach

- If there has been changes to the Owner's Project Requirements (OPR) (established in P1), confirm that the Reference Model structural bay model uploaded at the end of the schematic design phase still meets the updated OPR.
- Upload the final Selected Design Model structural bay model and reports that show 10% reduction in GWP impact compared to the submitted Reference Model structural bay model. The Selected Design Model should represent the closest available approximation of the building as it will be built.
- Required submittal files for Athena users:
  - Athena IE base files (Reference Model and Selected Design Model)
  - Reports: "Detailed LCA Results by Assembly Group Embodied Effects" in table format (reports for both Reference Model and Selected Design Model)
- Required submittal files for Tally users:
  - Revit model files with included Tally specifications (Reference Model and Selected Design Model)
  - Reports: "Full Building Summary" (reports for both Reference Model and Selected Design Model)

GWP Reduction Path 3 – Material-Level LCA Approach

- Upload a final version of the completed Path 3 Compliance Calculator. The Impact Score computed by the calculator must be 1.6 or lower to achieve compliance. Also input the Impact Score to the Tracking Tool.

Meeting the Guidelines: M.1B

Select which product option(s) to pursue. Early product research can help the project team capitalize on opportunities for products contributing to multiple credits and options. Individual products may contribute under either Option 1 or Option 2 but not be counted toward both.

The required scope of this guideline is for permanently installed building products, excluding mechanical, plumbing, electrical (MEP), and specialty equipment and items purchased for temporary use on the project. Furniture is not considered permanently installed and is not required to be included in the submission.

Option 1 is for projects with permanently installed products that have a product-specific declaration adhering to third-party certification programs to ensure that they conform to ISO 14044, which defines how LCAs are critically reviewed.

Option 2 is for projects with products with either product-specific or Environmental Product Declarations (EPDs) or industry-wide EPDs. Products must be sourced from multiple manufacturers, as indicated in the Required Performance Criteria. Various thresholds are available to accommodate stages of EPD development in different industries.

The table below compares different EPD formats to product-specific declarations:

	Product-Specific Declaration	Industry-Wide EPD	Product-Specific EPD
Data are critically reviewed	x	x	x
Data are specific to product	x		x
Data are reported according to product category rules (PCR)			x

Reference Guide for Building Design and Construction. Washington, DC: US Green Building Council, 2013. Print.

Suggested Implementation in the Design Process:

In Predesign and early design, refer to Additional Resources section below for information on product-specific declarations, EPDs, and how to obtain them.

Use the databases listed in Tools & Resources to search for common building product categories with disclosed EPDs. Material categories that are likely to have EPDs are wood products and interior finishes.

If, at this stage, a particular manufacturer and/or product is intended as a partner, contact manufacturer and learn about their current product life-cycle assessments. Refer to Tools and Resources section of M.1B for information on how to create a product-specific declaration or an Environmental Product Declaration.

Establish an initial list of products or building materials for the project. Review and update this list at each stage of the project. This will be useful for the Design phase in order to research compliant products. Also track whether the products or product categories identified are anticipated to meet option 1 (product-specific declaration) or option 2 (EPD).

Through the design process, refine selection of products and/or materials and establish a list of potential manufacturers. Review online resources for available product-specific declarations or EPDs that match the specified products or building materials for the project. Contact manufacturers and inquire about their current product life-cycle assessments. If needed, provide information on how to create a product-specific declaration and/or an EPD. Create specifications ensuring that this guideline can be met. Some additional information on specifying compliant products can be found under Additional Resources below.

Begin collecting documentation on compliant products by compiling product-specific declarations and/or EPDs and upload to the B3 Guidelines Tracking Tool. Declarations are typically in the form of a PDF document. If a product-specific declaration or EPD is in the process of being created for a particular product or building material, a PCR may be submitted in the Design phase and replaced by the completed documentation at the Final Design phase in the B3 Guidelines Tracking Tool.

In the construction documents phase of the project, establish final selection of compliant products and/or materials, ensuring that at least five meet the criteria here. It is recommended that the design team have researched and specified more than five products anticipating that some may not be eventually installed in the product due to requested changes or product availability. In the Tracking Tool submit at least five final product-specific declarations or EPDs. If necessary, make appropriate updates to products where only a PCR was submitted in the previous phase. Keep all documentation pertaining to specified products or materials.

During construction check in periodically with team members (contractors, subcontractors, and suppliers) to verify progress toward guideline achievement and address any gaps in credit compliance.

Continually track substitutions and change orders to ensure replacement products comply with the guidelines. Any product and/or building material substitutions or submittals should be carefully reviewed by the design team for compliance with the guidelines. Compile documentation to verify environmental claims for each product. Retain product data for all materials that contribute to guideline compliance.

Documentation of Product-Specific Declarations:

Declarations based on a life-cycle assessment of a product but not constituting a full EPD: To document this claim, the project team must provide the following information:

- Name (declaration holder or producer, typically the manufacturer)
- Contact information
- Product type
- Product name
- Product description
- Summary of impact categories measured and overall values
- Functional unit
- Standards met
- Independent review body name, including a review statement.

Documentation of Environmental Product Declarations (EPDs)

Documentation of an EPD (this includes Industry-wide or "generic" declarations, and product-specific Type III declarations). The project team must provide the following:

- Declaration holder (the company, usually the manufacturer, that the EPD is attributed to).
- EPD program operator (the entity that creates and registers the EPD).
- LCA verifier (the third-party entity that verifies the life cycle assessment).
- PCR reviewer (the third-party entity that has reviewed the product category rules).
- During the selection of products with EPDs, identify two items about the document: the type of EPD it is, and the summary that will be uploaded for guideline compliance.

Note that similar products from the same manufacturer can be counted as separate products if they have distinct formulations, but not if they are just aesthetic variations or reconfigurations. For example: Paints of different gloss levels are separate products, but different colors of the same paint, or different colorways of the same carpet, are not. During collection of EPDs ensure that EPD documentation includes a summary sheet of measured impacts.

Submittal Requirements: M.1B

Design:

- M.1B: Submit at least five different Product Declarations or Environmental Product Declarations that comply with the guideline requirements.

Final Design:

- M.1B: Submit at least five different Product Declarations or Environmental Product Declarations that comply with the guideline requirements.

Additional Resources

Standard EN15978: "Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method" https://www.en-standard.eu/csn-en-15978-sustainability-of-construction-works-assessment-of-environmental-performance-of-buildings-calculation-method/

Environmental Product Declarations: The International EPD® System: www.environdec.com/

Healthy Building Network and Pharos: www.healthybuilding.net/content/pharos-v3

Thinkstep: www.thinkstep.com

Underwriter's Laboratory (UL) SPOT database: www.ul.com and https://spot.ulprospector.com/en/na/BuiltEnvironment

ICC Evaluation Service: ICC-ES technical evaluations: www.icc-es.org

NSF International: www.nsf.org

Declare Products: www.living-future.org/declare-products

Cradle2Cradle: www.c2ccertified.org

Greenguard: UL Environment's GREENGUARD Certification program: www.greenguard.org/

Ecoinvent: http://www.ecoinvent.org/

Athena Sustainable Materials Institute: http://www.athenasmi.org/our-software-data/lca-databases/

openLCA Nexus: https://nexus.openlca.org/database

ISO Standards: http://www.iso.org/iso/home.htm

Glossary

Reference Building

A base-case whole-building LCA model used to compare performance with design cases. Embodied global warming potential (GWP) reductions for compliance Path 1 are measured by comparing embodied GWP of the design cases to the embodied GWP of the Reference Building. There are four accepted methods of determining the design of the Reference Building, discussed in the Meeting the Guidelines section.

Selected Building Design

The final design case whole-building LCA model, representing the building as it is expected to be built. The final global warming potential (GWP) reduction for compliance Path 1 is measured by comparing embodied GWP of the Selected Building Design to the embodied GWP of the Reference Building.

Reference Model

A base-case structural bay LCA model used to compare performance with design cases. Embodied global warming potential (GWP) reductions for compliance Path 2 are measured by comparing embodied GWP of the design cases to the embodied GWP of the Reference Model. The exact contents of the structural bay model are discussed in the Meeting the Guidelines section.

Selected Design Model

The final design case structural bay LCA model, representing the building as it is expected to be built. The final global warming potential (GWP) reduction for compliance Path 2 is measured by comparing embodied GWP of the Selected Design Model to the embodied GWP of the Reference Model.

Guideline M.2: Environmentally Preferable Materials

Intent

To improve environmental impacts of construction through the selection of environmentally preferable materials and products.

Required Performance Criteria

A. At least 55% of the total building materials used in the project must have one of the following attributes: salvaged or reused, recycled content, recyclable, bio-based, responsibly sourced or regional as defined in Sections 1 through 6 below. The combined calculation is based on mass, volume or cost. Where a material has more than one attribute, the material value will be multiplied by its number of qualifying attributes.[42]

1. Salvaged or reused materials and components:
   i. The salvaged material content will be determined based on the actual mass, volume, or cost of the salvaged material or the cost of a comparable alternative component material. Portions of a building retained and reused in a renovation may contribute in this category.[43]
2. Recycled content:
   Recycled content building materials must comply with one of the following:
   i. Contain not less than 25% combined postconsumer and/or pre-consumer recovered material, and be recyclable (see definition in 3 below).
   ii. Contain not less than 50% combined postconsumer and/or pre-consumer recovered material.
3. Bio-based:
   Bio-based materials are materials that comply with one or more of the following:
   i. The bio-based content is not less than 75% as determined by testing in accordance with ASTM D6866.
   ii. The requirements of USDA 7CFR Part 2902.
4. Responsible sourced:
   Responsibly sourced materials are materials that comply with the following:
   i. Wood and wood products labeled in accordance with the following standards:[44]
   ii. If wood comes from a North American source, it is certified using SFI, FSC, CSA, or ATF.
   iii. If wood comes from a source outside North America, it is certified using FSC or PEFC.
   iv. Other approved standards for extraction of raw materials (see additional resources in Meeting the Guidelines below).

[42] This section is aligned with International Green Construction Code (IGCC) and ANSI/ASHRAE/USGBC/IES Standard 189.1, Section "505.1 Material selection and properties." Areas that differ are noted in subsequent footnotes. Recycleable materials contribute to the IGCC guideline but do not contribute to meeting this guideline

[43] Salvaged or reused category differs from the IGCC requirements.

[44] Wood product requirements differ from the IGCC.

5. Regional:
   Regional materials or components must be composed of resources that are recovered, harvested, extracted, and manufactured within a 500-mile radius of the building site.
   i. Where only a portion of a material or product is recovered, harvested, extracted, and manufactured within 500 miles, only that portion can be included.
   ii. Where resources are transported by water or rail, the distance to the building site must be determined by multiplying the distance that the resources are transported by water or rail by 0.25, and adding that number to the distance transported by means other than water or rail.

Recommended Performance Criteria

B. At least 75% of the total building materials combined to be used in the project must have one of the following attributes: salvaged or reused, recycled content, recyclable, bio-based, responsibly sourced, or regional as defined in the preceding section.

Meeting the Guidelines

Implementation During the Design Process:
During Design, make initial selection of building materials and products with the following attributes: salvaged or reused, recycled content, recyclable, bio-based, responsibly sourced, or regional.

During the construction documents phase, represent chosen materials from Guideline M.2 in drawings and specifications. Ensure that 55% compliance level for environmentally preferable materials is met. Through construction, monitor submittals to ensure project includes selected materials; review substitutions based on selected criteria to ensure consistency and compliance with goals and objectives.

Other Approved Responsible Sourcing Standards:

There are no additional approved responsible sourcing standards at this time.

Submittal Requirements

Design:

- M.2A and M.2B: Selection of preliminary calculation method (mass, volume, or cost), total anticipated material mass, volume or cost, a list of building materials anticipated to achieve compliance with this guideline. This will include the material name, manufacturer (if known at this phase) and the percent contribution of each attribute category (salvaged or reused, recycled content, recyclable, bio-based, responsibly sourced, or regional).

Final Design:

- M.2A and M.2B: Selection of calculation method (mass, volume, or cost), total anticipated material mass, volume or cost, a list of building materials anticipated to achieve compliance with this guideline. This will include the material name, manufacturer (if known at this phase) and the percent contribution of each attribute category (salvaged or reused, recycled content, recyclable, bio-based, responsibly sourced, or regional).

Closeout:

- M.2A and M.2B: Verification of calculation method (mass, volume, or cost), total anticipated material mass, volume or cost, a list of installed building materials used to achieve compliance with this guideline. This will include the material name, manufacturer (if known at this phase) and the percent contribution of each attribute category (salvaged or reused, recycled content, recyclable, bio-based, responsibly sourced, or regional).

Additional Resources

2015 International Green Construction Code: https://www.iccsafe.org/codes-tech-support/international-green-construction-code-igcc/international-green-construction-code/

ANSI/ASHRAE/USGBC/IES Standard 189.1-2014, Standard for the Design of High Performance Green Buildings: https://www.ashrae.org/resources--publications/bookstore/standard-189-1

ASTM D6866: https://www.astm.org/Standards/D6866.htm

SFI Standard: http://www.sfiprogram.org/sfi-standard/

FSC STD-40-004 V2-1 EN: https://us.fsc.org/preview.fsc-std-40-004-v3-0-chain-of-custody-certification.a-561.pdf

CSA Standard: http://www.csasfmforests.ca/

PEFC Council Technical Document: https://www.pefc.org/resources/technical-documentation/pefc-international-standards-2010

USDA 7CFR Part 2902: https://www.gpo.gov/fdsys/granule/CFR-2010-title7-vol15/CFR-2010-title7-vol15-part2902

Glossary

Bio-Based Material

A commercial or industrial material or product, other than food or feed, that is composed of, or derived from, in whole or in significant part, biological products or renewable domestic agricultural materials, including plant, animal, and marine materials, or forestry materials (IGCC 2015).

Post-Consumer Recycled Content

The proportion of recycled material in a product generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product that can no longer be used for its intended purpose. This includes returns of material from the distribution chain (IGCC 2015).

Pre-Consumer (Post-Industrial) Recycled Content

The proportion of recycled material in a product diverted from the waste stream during the manufacturing process. Pre-consumer recycled content does not include reutilization of material such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it (IGCC 2015).

Raw Material

The basic substance from which products are made, such as concrete, glass, gypsum, masonry, metals, recycled materials (e.g., plastics and metals), oil (petroleum, polylactic acid), stone, agrifiber, bamboo, and wood (LEED v.4).

Reuse

To divert a material, product, component, module, or a building from the waste stream in order to use it again (IGCC 2015). Reuse includes the recovery and reemployment of materials recovered from existing building or construction sites. Also known as salvage (LEED v.4).

Total Building Materials

Includes all building materials except electrical, mechanical, plumbing, security and fire detection, and alarm equipment and controls, automatic fire sprinkler systems, elevators and conveying systems (IGCC 2015).

Wood

Plant-based materials that are eligible for certification under the FSC and other programs. Examples include bamboo and palm (monocots) as well as hardwoods (angiosperms) and softwoods (gymnosperms) (LEED v.4).

Guideline M.3: Waste Reduction and Management

Intent

To minimize use of resources and negative environmental impacts through design decisions and careful reduction and management of waste generated during the construction process and building occupancy.

Required Performance Criteria[45]

A. Material Conservation and Waste Management Plan[46]

Create a material conservation and waste management plan that includes the sections outlined below:

1. A plan to adaptively reuse an existing structure or salvage and reuse materials from an existing structure being demolished or deconstructed onsite.
2. A plan to select materials with appropriate durability for service life. In many cases, state-funded buildings are intended to have a 50–100 year service life for the structure and envelope.
3. A plan to specify the use of prefabricated products, preassembled products, and/or modular building units to minimize construction waste onsite.
4. A plan that addresses both partial deconstruction (for renovations) and total deconstruction (for end-of-life removal) of the building to maximize the reuse and recycling of building components and materials. Indicate specific strategies to facilitate disassembly.
5. A construction waste management plan that includes the following:
    i. Specification of materials to be diverted from disposal by efficient usage, recycling, reuse, manufacturer's reclamation, or salvage for future use, donation or sale.
    ii. Specification of the percentage of materials to be diverted ; calculate by weight or volume, but not both. Include separate average percentages for those materials collected by construction and demolition materials processing facilities that end up as alternative daily cover and incineration.
6. An operational waste plan that includes the following:
    i. Description of waste streams and discuss how waste will be minimized and diverted from disposal (recycled, composted, reverse distribution).
    ii. Description of the collection plan including a collection plan for consumables and durables (this can be done at a campus or organization scale).

B. Construction Waste Reduction

At least 75% of nonhazardous construction and demolition waste must be diverted from landfill. The percentage of materials diverted can be calculated by weight or volume, but not both.[47]

For the purposes of this section, construction materials and waste include, but are not limited to (1) all materials delivered to the site and intended for installation prior to the issuance of the certificate of occupancy, including related packaging; (2) construction materials and waste removal during demolition or razing. For the purposes of this section, construction and waste materials do not include land-clearing debris (including trees, rocks, and vegetation), excavated soils, and fill and base materials such as topsoil, sand, and gravel. Waste used as alternative daily cover or in waste-to-energy incineration will not be counted as diverted material.

[45] This section is aligned with International Green Construction Code (IGCC) and ANSI/ASHRAE/USGBC/IES Standard 189.1, Section "1006.1 Deconstruction and demolition material and waste management plan." Areas that differ are noted in subsequent footnotes.
[46] Differs from the IGCC requirements.
[47] Differs from the IGCC requirements.

Recommended Performance Criteria

C. Additional Construction Waste Reduction
At least 90% of nonhazardous construction and demolition waste must be diverted from landfill. The percentage of materials diverted can be calculated by weight or volume, but not both.

Meeting the Guidelines

During Predesign, ensure that adequate space is planned for dedicated recycling areas, processing and holding space, and reverse distribution space in the building. Begin to draft a Material Conservation and Waste Management Plan.
At site selection, evaluate the potential for adaptive reuse of an existing structure or salvage and reuse materials from an existing structure being demolished onsite.
Ensure that products are selected and specified that have appropriate durability. Specify the use of prefabricated products, preassembled products, and/or modular building units to minimize construction waste onsite. Incorporate design for disassembly and deconstruction that addresses both partial deconstruction (for renovations) and total deconstruction (for end of life removal). Verify that recycling areas are included in plans.
As the construction documents are being developed, incorporate details and specifications that support the minimization of material use and clearly require construction waste management that meets project requirements. Include specification language mandating compliance with the pursued level of construction waste landfill diversion. Request reduced, reused, or eliminated material packaging. Develop detailing and construction recommendations that minimize material use and maximize performance of materials to support intended goals of durability, disassembly, and use of prefabricated products, preassembled products, and/or modular building units. Compile material and product documentation from the manufacturer, declaring life cycle and warranty recommendations indicating durable life cycle projections for building components. Provide specifications that require contractor submittals highlighting service life of materials installed.
During construction administration monitor submittals to ensure project construction waste diversion meets requirements. Review revisions to program to ensure consistency and compliance with goals and objectives.

Submittal Requirements

Design:

- M.3A: Material conservation plan.

Final Design:

- M.3A: Material conservation report (on execution of the material conservation plan), specification mandating waste management plan, and draft of operational waste management plan.

Closeout:

- M.3A: Operational waste management plan and waste management report
- M.3B and M.3C: A waste management report documenting actual construction waste disposal and recycling rates of at least 75% diversion (90% if pursuing M.3C), including receipts or other documentation related to diversion through the course of construction.

Additional Resources

2015 International Green Construction Code: https://www.iccsafe.org/codes-tech-support/international-green-construction-code-igcc/international-green-construction-code/

ANSI/ASHRAE/USGBC/IES Standard 189.1-2014, Standard for the Design of High Performance Green Buildings: https://www.ashrae.org/resources--publications/bookstore/standard-189-1

Living Building Challenge includes standards on net positive waste: https://living-future.org/lbc/

Glossary

Deconstruction:

The process of systematically disassembling a building, structure, or portion thereof, so that the materials, products, components, assemblies, and modules can be salvaged for repurpose, reuse, or recycling (IGCC 2015).

Guideline M.4: Health

Intent

To minimize potentially hazardous materials used in B3 projects.

Required Performance Criteria

A. Demonstrate that the chemical inventories of at least ten permanently installed interior materials from at least five different manufacturers do not contain likely hazardous materials by one of the following screening methods: [48]

1. GreenScreen List Translator: Qualifying materials must demonstrate, based on a full chemical inventory to 100 ppm, that they are free of List-Translator-1 (LT-1) or List-Translator Possible 1 chemicals (LT-P1) as defined by the most current version of GreenScreen.
2. Full GreenScreen Assessment: Qualifying materials must demonstrate, based on a full chemical inventory to 100 ppm that they are free of Benchmark-1 (BM-1) chemicals as defined by the most current version of GreenScreen. A GreenScreen label indicating the product is free of BM-1 chemicals is sufficient for this method.
3. Products certified under Cradle to Cradle v2 Gold or Platinum or Cradle to Cradle v3 Silver, Gold or Platinum.
4. Products certified as meeting Declare Label Declaration Status of LBC Red List Free

Qualifying materials that are among the ten most prevalent by area may be double-counted. If a project team is unable to find adequate available compliant materials, documentation of letters to manufacturers requesting GreenScreen BM-1, List Translator results for products not currently reporting GreenScreen hazard assessment will be accepted. The team may also document the request for materials that have identified BM-1 chemicals to remove these chemicals from the product. Each documented requests for product evaluation may contribute as one material under this guideline. Compliance is determined by identification and specification of compliant products. Manufacturers may report qualification under Part 1 or Part 2 above by inclusion in a Health Product Declaration (HPD).

[48] This section is aligned with in part on USGBC, "Materials and Resources Credit: Building product disclosure and optimization, Option 2: Material Ingredients," *LEED Building Design and Construction v.4*, though with different required numbers of materials submitted for compliance and with different available methods of chemical inventory verification.

B. Mercury content in fluorescent lamps. The mercury content in straight fluorescent lamps and compact fluorescent lamps must comply with the limitations stated below.[49]

1. Straight fluorescent lamps.
    i. Non-preheat straight, double-ended fluorescent lamps less than 70 inches (1800 mm) and greater than 21 inches (550 mm) in length and containing a medium bi-pin base or miniature bi-pin base must comply with the following:
    ii. T-5 lamps with a rated lifetime of less than 25,00 hours at 3 hours per start must not contain more than an average of 3 milligrams of mercury per lamp.
    iii. T-8 lamps with a rated lifetime less than 25,000 hours at 3 hours per start on an instant start ballast must not contain more than an average of 4 milligrams of mercury per lamp.
    iv. All other T5 or T8 lamps must not contain more than an average of 5 milligrams of mercury per lamp.
2. Compact fluorescent lamps.
    Single-ended pin- base and screw-base compact fluorescent lamps must not contain more than an average of 5 milligrams of mercury per lamp, and must be listed and labeled in accordance with UL 1993.
    Exception: mercury content is not limited for lighting integral to equipment or instrumentation and installed by the manufacturer, or for lamps with a high color-rendering index that is greater than or equal to 87.

Recommended Performance Criteria

C. Demonstrate that the chemical inventories of all permanently installed interior materials do not contain any Benchmark-1 chemicals as defined by the most current version of GreenScreen.
D. Demonstrate that the chemical inventories of at least ten different permanently installed interior materials from at least five different manufacturers do not contain any Benchmark-2 chemicals as defined by the most current version of GreenScreen.

Meeting the Guidelines

Implementation in the Design Process:

For M.4A, M.4C and M.4D:

In Predesign and early design, determine likely product categories that will contribute to compliance with this requirement. Early product research should be conducted to evaluate opportunities specific to project needs. This may be done by searching for approved products in databases or by contacting product reps and manufacturers. GreenScreen certification marks compliant with LEED v.4 are acceptable as documentation for B3 compliance. Health Product Declarations (HPDs) may also demonstrate GreenScreen results.

Through the design process refine contributing product list and look for opportunities to add contributing products as the design changes. A product may contribute toward M.4A, M.4C or M.4D if that product has been evaluated as defined in GreenScreen v1.2 Benchmark, has received a Cradle to Cradle (C2C) v2 Gold or Platinum or Cradle to Cradle v3 Silver, Gold or Platinum certification, or are certified as meeting Declare Label Declaration Status of LBC Red List Free.

[49] This section is aligned with International Green Construction Code (IGCC) and ANSI/ASHRAE/USGBC/IES Standard 189.1, Section "506.1 Mercury Content in Fluorescent Lamps."

Under GreenScreen products that have fully inventoried chemical ingredients to 100 ppm that have no LT-1, LT-P1 or BM-1 (Benchmark 1) hazards are:

- Any materials that have all its ingredients assessed with the GreenScreen List Translator and have been found to be free of LT-1 chemicals.
- Any materials for which all ingredients have undergone a full GreenScreen Assessment and have been found to be free of BM-1 chemicals.
- Any materials referenced in the Pharos or Portico databases and vetted for use in B3 Guidelines documenting either no LT-1 or no BM-1 chemicals.

For M.4B:

As in early design, evaluate opportunities for reduction in fluorescent fixtures to reduce the need for low-mercury bulbs. In construction documents specify any fluorescent lamps that fall under this guideline meet the limits specified above.

Submittal Requirements

Design:

- M.4A, M.4C, and M.4D: Submit list of identified product types anticipated to comply with this guideline.
- M.4B: Submit list of fluorescent lighting fixtures or systems expected to fall under this guideline.

Final Design:

- M.4A, M4C, and M4D: Submit specified materials list compliant with this guideline, including documentation of: GreenScreen compliance at one of the listed allowable levels or documentation of product manufacturer requests.
- M.4B: Submit list of fluorescent lighting fixtures or systems falling under this guideline and compliant specifications.

Closeout:

- M.4A, M.4C, and M.4D: Submit documentation of final product selection and any received responses from product manufacturers in response to requests for information.
- M.4B: Submit documentation that relevant lighting fixtures comply with this guideline.

Additional Resources

How to Use GreenScreen for LEED v.4: http://www.greenscreenchemicals.org/practice/leed

Full GreenScreen Chemical Hazard Assessment Procedure: http://www.greenscreenchemicals.org/learn/full-greenscreen-method

GreenScreen Assessment Report Template: https://www.pharosproject.net/uploads/files/gs/1405445287.pdf

GreenScreen Information Sources :https://chemicalprofiler.wiki.zoho.com/List-of-Lists.html

GreenScreen List Translator: http://www.greenscreenchemicals.org/method/greenscreen-list-translator

Understanding GreenScreen and List Translator Benchmarks: https://www.buildinggreen.com/primer/understanding-greenscreen-and-list-translator-benchmarks

GreenScreen Store: http://www.greenscreenchemicals.org/gs-assessments

Cradle to Cradle Certified Products Registry: http://www.c2ccertified.org/products/registry

Interstate Chemicals Clearinghouse: http://www.theic2.org/hazard-assessment

Declare Label: https://living-future.org/declare/declare-about/

Glossary

Interior Materials

Interior materials are defined as all materials interior to the enclosure's least vapor-permeable and continually air-sealed barrier system. For most enclosure systems, this definition will encompass all materials interior and exclusive of the vapor barrier. For some assemblies with several systems providing vapor impermeability, a further determination will need to be made.

Continually Air-Sealed Barrier System

A set of air-sealed building materials that is intended to prevent air-flow through a wall assembly. This may take the form of a continually sealed vapor barrier or a set of materials that when combined provide the least vapor-permeable system. Note that some materials have low vapor permeability but may not be part of a continually sealed system and would not be considered to be the boundary of the building's interior.