



PURDUE
UNIVERSITY™

SUSTAINABLE LANDSCAPE PLAN

WEST LAFAYETTE CAMPUS

IN SUPPORT OF
LANDSCAPING THE SUSTAINABLE CAMPUS
AN INDIANA WILDLIFE FEDERATION PROGRAM

APRIL 2012

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EXECUTIVE SUMMARY

Purdue University, West Lafayette Campus, is pleased to partner with the Indiana Wildlife Federation in developing this Sustainable Landscape Plan in support of the Landscaping the Sustainable Campus program. This plan is the culmination of a collaborative process undertaken by many professionals across several departments.

The development process began with an internal kick-off meeting on December 15, 2011 to discuss goals and a roadmap for implementation. Draft content was developed through March of 2012. Once a comprehensive draft was available, a meeting was held to solicit feedback with other on-campus operational departments including:

- Recreational Sports Grounds Department,
- Intercollegiate Athletics Grounds Department, and
- Golf Courses Grounds Department.

Representatives from several academic departments were also in attendance to explore the potentials for synergies with academics and research and to provide feedback on the Sustainable Landscape Plan as follows:

- Forestry and Natural Resources,
- Turfgrass Science,
- Horticulture and Landscape Architecture, and
- Botany and Plant Pathology / Pesticide Programs.

This Sustainable Landscape Plan is a comprehensive look at Purdue University's forward-thinking approach to landscape design, maintenance, and operations. In many cases, this document captures efforts that Purdue has been implementing for years based on innovative partnerships between operational units and world-class academic resources. In other cases, this document points to a path forward where Purdue can provide a more sustainable campus landscape while continuing to meet the needs and the expectations of the campus community.

Purdue University is delighted to be a part of the Landscaping the Sustainable Campus program to showcase Indiana institutions of higher education as exemplars of sustainable campus landscape stewardship. We look forward to a continued partnership with the Indiana Wildlife Federation in taking Purdue University to higher and higher levels of sustainability.



**SUSTAINABLE LAWN MAINTENANCE &
LANDSCAPING**

GOAL No. 2 - MOW HIGHER

SUSTAINABLE LAWN MAINTENANCE & LANDSCAPING

GOAL INTENT

Mow higher (only top 1/3 of grass) to develop and maintain a strong root system, an important aspect of healthy soil. Healthy, established turf grass decreases soil erosion and helps keep nutrients on your lawn.

PROCEDURE

Set mowing deck heights at 3.5 inches to ensure only the top 1/3 of the grass blade is removed during mowing. In general, less maintenance is required with higher mow cut heights, because higher mow cut heights promote deeper root systems. Deeper root systems have better access to nutrients and water in the soil. Additionally, taller grass provides shade to the soil which prevents weeds from germinating, thereby reducing the need for weed control measures.

Use mulching blades to return the clippings and their nutrients to the soil; also known as grasscycling, grass clippings can provide turfgrass with half of their annual fertilizer needs. Sharpen and change blades two times per week to ensure a clean and uniform cut. Promote healthy turf grass to discourage weed problems and reduce herbicide use.

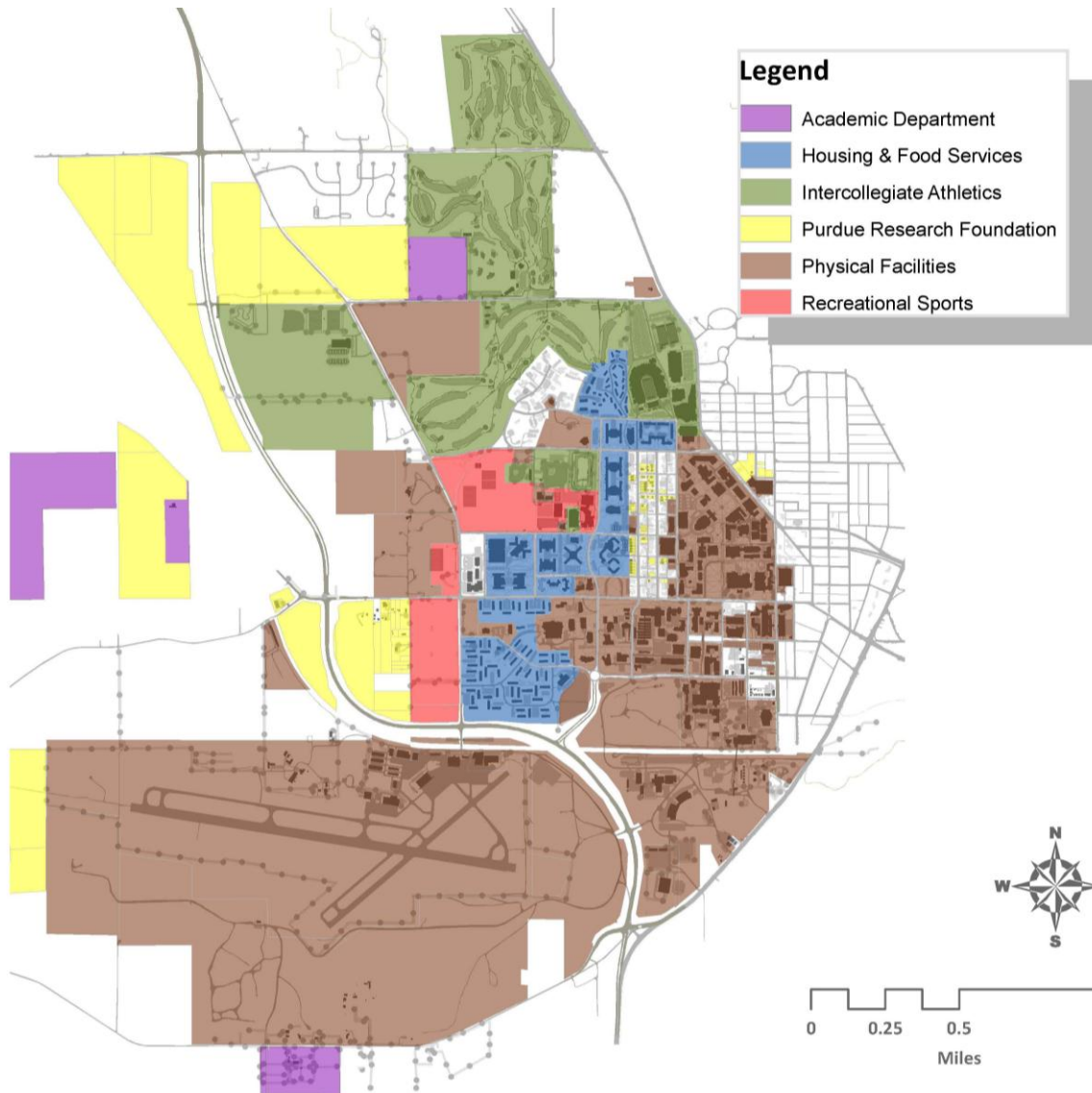
RELATED REFERENCES

Purdue University offers a Bachelor in Science Degree in Turfgrass Science and maintains an informative website with tips, publications, and descriptions of on-going research at www.agry.purdue.edu/turf/.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance. This prerequisite requires the development of "a site maintenance plan that outlines the long-term strategies and identifies short-term actions to achieve sustainable maintenance goals".¹

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan provides credit for the development and implementation of an environmentally sensitive landscape maintenance plan which could include turfgrass mowing criteria.

¹ The Sustainable Sites Initiative, The Sustainable Sites Initiative: Guidelines and Performance Benchmarks, 2009, p. 190.



Purdue University Campus Map Delineating Areas of Landscape Management Responsibility

CAMPUS CASE STUDY

Landscape operations and maintenance activities at Purdue University are implemented by several groups as shown above. Physical Facilities Grounds Department maintains the academic core, the Lafayette Purdue University Airport, the maintenance area to the south of campus, Horticulture Park, and the Housing and Food Services areas (under contract.) Within the Physical Facilities Grounds Department, there are three Landscape and Turf Maintenance Crews that care for over 1,150 acres of turf and landscape planting beds on campus. Landscape Specialists on these crews plant, fertilize, aerate, and mow grass during the spring, summer and fall. Each year, the Grounds Department grows, plants, and maintains approximately 30,000 annual plants / flowers which provide a wide array of color on campus.

GOAL No. 3 - UTILIZE COMPOSTING

SUSTAINABLE LAWN MAINTENANCE & LANDSCAPING

GOAL INTENT

Design a composting system to collect yard waste (grass clippings, fallen leaves, branches) and recycle it as mulch. This organic material already contains nutrients that microbes can release to replenish the soil. Rich soil absorbs and filters rainfall.

PROCEDURE

Use mulching mowers to return grass clippings and leaves back to areas of turfgrass. Collect brush and leaves for composting. Purdue Grounds manages two State-certified compost locations at Purdue. The primary location is in the gravel pit. In addition to composting leaves and brush from campus grounds, Purdue also has agreements in place to receive leaves and/or brush from the cities of Lafayette and West Lafayette. Brush is given to a private company, Soilmaker, which leases land in the gravel pit and partners with Purdue to recycle organic materials as soil amendments. All Purdue materials are weighed and the data is used to calculate the institutional landfill diversion rate. Compost processed by Purdue Grounds is used to amend topsoil that is used on capital and in-house construction projects on campus. Compost processed by Soilmaker is refined into several blends of gardening and topsoil amendments for purchase by private individuals and companies for their own use. The secondary State-approved compost site is located at the Grounds tree nursery. This is a quality blend of 'private stock' that the landscape maintenance, construction and greenhouse staff use for Purdue campus applications.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance. This prerequisite requires the development of "a site maintenance plan that outlines the long-term strategies and identifies short-term actions to achieve sustainable maintenance goals".²

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan provides credit for the development and implementation of a sustainable landscape maintenance plan which could include composting as a fertilizer strategy.

² The Sustainable Sites Initiative, [The Sustainable Sites Initiative: Guidelines and Performance Benchmarks](#), 2009, p. 190.



Jody Tishmack Running the Soilmaker Operation

CAMPUS CASE STUDY

Soilmaker, a business based on land leased from Purdue University, produces high-quality synthetic soil using leaves, brush, and grass clippings from Purdue and landscaping contractors (www.soilmaker.com). Soilmaker is operated by Jody Tishmack who has a Master's Degree in Soil Science, and who received her PhD in Civil Engineering from Purdue. The soil produced is sold to local municipalities, businesses, and residents.

It takes one to two years to produce rich, healthy soil from the compost materials depending on temperature and amount of rainfall. The process follows an exact 'recipe' with each ingredient carefully measured. "Composting is an art that you learn from mistakes," said Tishmack regarding the process. This endeavor earned Purdue, in conjunction with Eli Lilly and Company, the 2002 Governor's Award for Recycling and Reuse for a project which utilized soil from Soilmaker to replant 250 acres at the Chinook Coal Mines where acid soil had made plant growth impossible for more than 20 years.

GOAL NO. 4 - RESEARCH SUSTAINABLE PRACTICES ON CAMPUS SUSTAINABLE LAWN MAINTENANCE & LANDSCAPING

GOAL INTENT

Encourage students to lead research projects to determine the success of sustainable practices and consider innovative approaches to improve these practices on campus.

PROCEDURE

Encouraging the 'living laboratory' initiative is a sustainability goal of both the goal of both the Purdue University New Synergies Strategic Plan and the Sustainability Strategic Plan. Work with relevant academic departments (Horticulture and Landscape Architecture, Forestry and Natural Resources, Turfgrass Science, Botany and Plant Pathology / Pesticide Programs, Environmental and Ecological Engineering, Ecological Sciences and Engineering, Civil Engineering) to identify operational initiatives which are good candidates for faculty and student research and monitoring. Work with the Office of the Provost and the Office of University Sustainability to gain support for these academic / operational partnership and to publicize these efforts.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 incentivizes the monitoring and documentation of sustainable initiatives under Credit 9.1: Monitor Performance of Sustainable Design Practices. The intent of this credit is to "Monitor and document sustainable design practices to evaluate their performance over time and improve the body of knowledge on long-term site sustainability."³ Several Prerequisites and Credits are applicable for performance monitoring.

³ The Sustainable Sites Initiative, [The Sustainable Sites Initiative: Guidelines and Performance Benchmarks](#), 2009, p. 210.



Water Quality Monitoring Station at Birck Boilermaker Golf Complex

CAMPUS CASE STUDY

Purdue's Birck Boilermaker Golf Complex consists of two 18-hole championship golf courses. The Kampen Course, designed by renowned golf course architect Pete Dye, functions as a living laboratory for several faculty research teams with sustainability initiatives. A water purifying reclamation system operates course-wide; consisting of a man-made wetlands (which includes over 12,000 aquatic plants) and a lake, this system protects the water quality of the adjacent Celery Bog. This integrated system filters the stormwater from the course and the surrounding mixed-use neighborhood such that the water quality leaving the course is better than the water coming in from the neighborhood. Monitoring of water quality was performed at six locations over several years and has been documented in several peer-reviewed papers including a USGA study titled "Constructed Wetlands on Golf Courses Help Manage Runoff from the Course and Surrounding Areas." Sampling includes oxygen content, temperature, pH, and other parameters. Sampling for pesticides, metals, nutrients, salts, and petroleum products is also conducted after significant rainfall events. This initiative provided an opportunity for research, but also due to the number of papers and articles written provides a best management practice exemplar for other golf complexes. As several other research projects are underway, the Kampen Course continues to be a living laboratory for researchers at Purdue.



**PESTICIDE / HERBICIDE
USE REDUCTION**

GOAL NO. 1 – UTILIZE INTEGRATED PEST MANAGEMENT

PESTICIDE / HERBICIDE USE REDUCTION

GOAL INTENT

Develop an efficient and effective Integrated Pest Management (IPM) plan by selecting products that are least harmful to humans and the environment. Begin implementation of the IPM plan.

PROCEDURE

Integrated Pest Management (IPM) combines biological, cultural, physical and chemical tools in a way that minimizes economic, health, and environmental risks. Supervisors should inspect turf and shrubs on a regular basis to assess the health of plants and to be watchful for pest presence / damage. Maintain good turf quality to reduce the use of herbicides for weed control; proper use of turf fertilizer (phosphorus-free) and other turf maintenance practices like aeration, correct mowing height (3.5 inches), and using mulching blades, herbicide use can be reduced considerably. Non-chemical strategies and approaches should be implemented prior to resorting to chemical use; horticulture oil should be used whenever possible. If a chemical application is required, spot spraying should be utilized instead of a general full coverage approach, and the least hazardous pesticide should be selected. Staff who apply regulated pesticides must maintain their Indiana 3A and/or 3B certifications (3A covers pesticide or fertilizer applications to ornamental plantings and 3B covers pesticides or fertilizers on turf areas). Application equipment should always be calibrated and always follow the label's directions when applying any product. During design, landscape architects should select plant materials that discourage pest problems.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance which includes criteria for integrated pest management.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan provides credit for the development and implementation of a sustainable landscape maintenance plan which addresses outdoor integrated pest management.

IPM SCHOOL TECHNICAL RESOURCE CENTER
 Integrated Pest Management for Schools and Childcare Facilities

[Illinois](#) | [Indiana](#) | [Michigan](#) | [Minnesota](#) | [Ohio](#) | [Wisconsin](#)

Welcome to the **Midwest Technical Resource Center** for IPM in schools and daycares. Our goal is to help you maintain safe and pest-free learning environments for children through improved pest management practices.

For general information on Integrated Pest Management, use the menu to the left. For specific information about state regulations and resources, click on your state.

What is IPM?

IPM is a process for achieving long term, environmentally sound pest suppression through the use of a wide variety of technological and management practices. Control strategies in an IPM program extend beyond the application of pesticides to include structural and procedural modifications that reduce the food, water, living space and access used by pests.

By eliminating potential food, water and living space for pests, and sealing up their entry routes into buildings, the need for pesticides is greatly reduced. Pesticides are used only when a confirmed pest problem is present (no preventative treatments). Then, the least hazardous pesticide effective for control of a specific pest is applied using precision, targeted treatments in areas not contacted or accessible to the children, faculty or staff.

[Pest Answers](#)
[Links](#)
[Site Map](#)
[Text Version](#)

CAMPUS CASE STUDY

Purdue University maintains the IPM Technical Resource Center to assist schools and childcare facilities in developing integrated pest management programs (<http://extension.entm.purdue.edu/schoolipm/>). This resource covers many facets of developing an IPM program (both for indoors and outdoors) and includes an IPM Compliance Checklist with the following items:

- ✓ Adopt an IPM policy
- ✓ Designate an IPM coordinator for each building
- ✓ Inspect all buildings and grounds
- ✓ Perform repairs as needed to prevent pest access to buildings or to hiding spaces in walls and equipment
- ✓ Review sanitation practices and reduce clutter
- ✓ Set up a monitoring program for pests
- ✓ Identify potential pest species found and determine a control strategy
- ✓ Only apply pesticides when a known pest is present
- ✓ If a pesticide is needed, select the least hazardous pesticide
- ✓ Keep records of pest activity and control measures
- ✓ Evaluate the program on a regular basis

The US Environmental Protection Agency has also developed an IPM resource titled Integrated Pest Management for Schools: A How-to Manual (www.epa.gov/pesticides/ipm/schoolipm/).

GOAL NO. 2 – TARGET PEST ERADICATION STRATEGIES

PESTICIDE / HERBICIDE USE REDUCTION

GOAL INTENT

Identify which pests to target and determine the best eradication approach for each pest. Use spot treatment, if needed, to control weeds and insect pests.

PROCEDURE

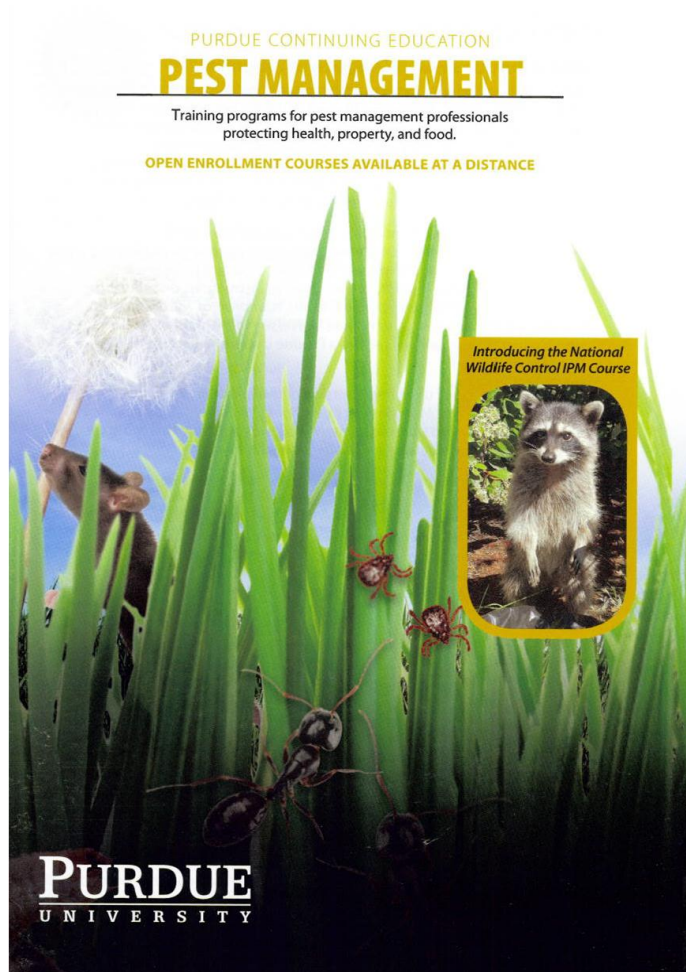
Identify the specific pest (plant or animal) to be addressed. Non-chemical options should be evaluated and implemented, if possible, prior to resorting to chemical sprays and poisons, which can cause allergic reactions if unwanted contact occurs with people. Non-chemical strategies vary from insecticidal soap for weeds to spring or glue traps for rodents. If chemical treatment is warranted, utilize the least toxic strategies. Use spot treatment to target specific areas and to avoid broadcast applications which could negatively impact non-pest organisms and the environment.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance which includes criteria for integrated pest management.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan provides credit for the development and implementation of a sustainable landscape maintenance plan which addresses outdoor integrated pest management.

Purdue University, Entomology Extension has developed an IPM resource for schools and daycares; most of the strategies are also applicable to higher education institutions (<http://extension.entm.purdue.edu/schoolipm/>).



CAMPUS CASE STUDY

Purdue Extended Campus (PEC) offers continuing education courses in pest management. These courses have been “developed primarily for the pest control industry, the courses are part of a continuing urban and industrial pest management curriculum designed to provide the pest control industry with accessible and affordable university-quality training”.⁴ More information is available online (www.distance.purdue.edu/training/pest/) and the available topics include:

- Introduction to Urban and Industrial IPM
- Turfgrass IPM
- Termites and Other Wood Destroying Pests IPM
- IPM in Public Buildings and Landscapes
- Intermediate Level Urban and Industrial IPM
- Invasive Borers IPM
- National Wildlife Control IPM

⁴ Purdue Extended Campus, Purdue Continuing Education Pest Management Brochure, 2012, p. 1

GOAL NO. 3 – MITIGATE RISKS OF CHEMICAL EXPOSURE

PESTICIDE / HERBICIDE USE REDUCTION

GOAL INTENT

Avoid applying chemicals near water sources, especially areas prone to erosion, to keep toxic compounds from reaching aquatic ecosystems, and avoid applying them in high-traffic areas to reduce health risk to students.

PROCEDURE

Chemical use around water bodies should be avoided, if possible, thereby avoiding the risk of chemical runoff into streams and tributaries, as well as campus water sources. Use mechanical or physical means of controlling weeds, either weed whackers or physical weed pulling, as opposed to chemical means of controlling invasive plants.

In order to use chemicals near water sources, establish a threshold or buffer zone where chemicals should not be used. Encourage the growth of tougher turf around the edges of water. Seed this area with native plant species with extensive root systems to filter runoff. Doing so also aids in erosion control.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance which includes criteria for integrated pest management.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan provides credit for the development and implementation of a sustainable landscape maintenance plan which addresses outdoor integrated pest management.

Purdue University Entomology Extension has developed an IPM resource for schools and daycares; most of the strategies are also applicable to higher education institutions (<http://extension.entm.purdue.edu/schoolipm/>).



Harrison Pond

CAMPUS CASE STUDY

Harrison Pond is a water body near the Wade Power Plant at Purdue University. Grounds Maintenance crews avoid using chemicals near the pond altogether. Instead, to control pests and invasive species, the department has established a buffer zone around the pond. Shrub honeysuckle was removed from the edges to foster the growth of ground cover with extensive root systems. To continue controlling the growth in the buffer zone the crews mechanically and physically remove weeds and other invasive plant species.

The shrub honeysuckle plants were removed during the winter. If the ground cover does not grow back thick enough on its own, the Grounds Department will hydro-seed the area to implement better erosion control, as well as, filtering runoff into the pond.

GOAL NO. 4 – UTILIZE CHEMICAL-FREE APPROACHES

PESTICIDE / HERBICIDE USE REDUCTION

GOAL INTENT

Use alternative, chemical-free forms of weed and pest management such as insecticidal soap, weed removal by hand, and companion planting. Organize community members to help with weed pulling in major problem areas.

PROCEDURE

Use insecticidal soaps and horticulture oil instead of herbicidal sprays to control pests and weeds where possible. The use of horticulture oil on trees to protect against insects has to be done in the right window of opportunity to be effective; do not apply horticulture oil during periods of extremely high or freezing temperatures, when plants are wet, or during the fall. Use insecticidal soap as an alternative to synthetic insecticides. Target specific areas at the right time to be effective against insect pests. Identify problem areas. Spot treat those areas instead of using a blanket approach.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance which includes criteria for integrated pest management.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 3: Integrated Pest Management, Erosion Control and Landscape Management Plan provides credit for the development and implementation of a sustainable landscape maintenance plan which addresses outdoor integrated pest management.

Purdue University Entomology Extension has developed an IPM resource for schools and daycares; most of the strategies are also applicable to higher education institutions (<http://extension.entm.purdue.edu/schoolipm/>).

Purdue University Professor Chris Sadoff has written a guide to handling insects that are normally resistant to chemical sprays with insecticidal soaps, entitled *Scale Insects on Shade Trees and Shrubs* available through Purdue Extension (<http://extension.entm.purdue.edu/publications/E-29.pdf>).



Euonymus Scale

CAMPUS CASE STUDY

Purdue Grounds Department has used horticulture oil and insecticidal soap effectively around the Materials and Electrical Engineering Building (MSEE) against ground cover and insect pests. To protect beds against invasive ground cover horticulture oil is the product of choice.

Euonymus scale is a small insect that, when stationary on the plant, is very difficult to kill. There is a time frame or window of opportunity, in which the insect is vulnerable to insecticidal soaps. Grounds determined the time frame and used soaps to manage the Euonymus Scale insects. This window of opportunity varies with species. The Grounds Department identifies the kind of insect it is dealing with and takes the appropriate steps to manage the pest.



INVASIVE SPECIES ERADICATION

GOAL NO. 1 – DEVELOP A REMOVAL STRATEGY FOR INVASIVE SPECIES

INVASIVE SPECIES ERADICATION

GOAL INTENT

Develop a removal strategy plan for all invasive species that sets goals for eliminating these species from specific areas of campus and creating healthy habitat structures.

PROCEDURE

Staff should maintain an evolving database of invasive species and their locations on campus. Species which demonstrate invasiveness which cannot be practically managed should be removed during maintenance, renovation or construction efforts. Species which spread via wind, bird, or insect would typically fall into this category. Removal of invasive plant material should be done when resources are available and can be used as an educational opportunity with academic programs and as an engagement opportunity with volunteer groups. Replacement with non-invasive plant material will complete this cycle, illustrating the benefits of corrective efforts. In addition, design standards should be maintained which prohibit invasive species from being included in landscape plans for new construction.

RELATED REFERENCES

The Purdue University Physical Facilities Consultant's Handbook includes a list of invasive species prohibited on campus in Guidelines by CSI Division – Item 109 - CSI# 32 9300 Exterior Undesirable Plants.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development and implementation of a management plan for “the control and subsequent management of known invasive plants found on site to limit damage to local ecosystem services”⁵ under Credit 4.1: Control and Manage Known Invasive Plants Found On Site.

The Sustainable Sites Initiative also requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance which includes criteria for identifying, monitoring, management, and removal of invasive plant species.

Indiana Department of Natural Resources (IN DNR) maintains Invasive Species Assessments for plants IN DNR has deemed to be invasive species (<http://www.in.gov/dnr/4619.htm>).

⁵ The Sustainable Sites Initiative, The Sustainable Sites Initiative: Guidelines and Performance Benchmarks, 2009, p. 88.



Before and after photos of the honeysuckle removal. The photo above shows the honeysuckle before, and the photo to the right shows the area after removal.



CAMPUS CASE STUDY

Horticulture Park is a natural area of campus that is maintained as an educational resource on the western edge of campus. Grounds Maintenance has designated areas of Horticulture Park as 'no mow' zones in order to keep it natural as part of the department's sustainability efforts. Those 'no mow' areas have become overrun with honeysuckle.

The Grounds Maintenance Department removed 40 to 50 truckloads of honeysuckle from Horticulture Park. Honeysuckle is an invasive plant and plans were made to remove the weed. This removal was paid for out of the department's operating budget. The plant was removed mechanically, with a backhoe, and physically, by pulling and spot removal.

The large patches of honeysuckle have been removed, but it keeps creeping back. Grounds Maintenance monitors areas where honeysuckle creeps in and works to remove it by mechanical and physical means. This keeps the plant from gaining ground again.

GOAL NO. 2 – MINIMIZE USE OF EXOTIC PLANTS

INVASIVE SPECIES ERADICATION

GOAL INTENT

Minimize use of exotic plants by selecting Indiana native species for new or recently restored areas.

PROCEDURE

Consider the exclusive use of native plants for all future landscape renovation and new construction projects. Where native plants are unable to perform necessary functions or provide desired aesthetic outcomes, utilize non-invasive plant species.

RELATED REFERENCES

The Purdue Arboretum (www.purdue.edu/buildings_grounds/trees/website/) supports the continued implementation of native plants in the area bound by State Street, Agricultural Mall, University Street, and Marsteller Street. This area was identified as a future destination garden for showcasing the use of native plants in traditionally ornamental applications. Native planting in this area is supported by the natural resources faculty in nearby buildings.

The Purdue University Physical Facilities Consultant's Handbook includes a list of invasive species prohibited on campus in Guidelines by CSI Division – Item 109 - CSI# 32 9300 Exterior Undesirable Plants.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the use of “plants that are non-invasive and appropriate for site conditions, climate, and design intent to improve landscape performance and reduce resource use” under Prerequisite 4.2: Use Appropriate, Non-Invasive Plants. Credit 4.2: Use Native Plants incentivizes the use of plant species native to the ecoregion.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 5.1: Site Development – Protect or Restore Habitat incentivizes the installation of native or adapted vegetation on previously developed sites to restore habitat and promote biodiversity.

Indiana Department of Natural Resources (IN DNR) maintains Invasive Species Assessments for plants IN DNR has deemed to be invasive species (<http://www.in.gov/dnr/4619.htm>).



Harrison Hall Landscape Bed Improvement Project - Before



Harrison Hall Landscape Bed Improvement Project – After

CAMPUS CASE STUDY

Harrison Residence Hall on Purdue's West Lafayette campus had landscape beds with some trees, minimal shrubs, and significant areas of exposed soil. A University Residences initiative to improve the appearance at main entrances offered an opportunity to enhance such spaces. Existing beds were redesigned to improve turfgrass mowing, root conditions, and curb appeal. Student employees removed weeds and invasive species, and shaped and graded the beds using hand tools. They sourced options for plant material and installed new and transplanted perennials to improve the space. Species installed at this site, and others like it included Coneflower, Fern, Heuchera, Columbine, Aster, Geranium, Coreopsis, and Black Eyed Susan. Future goals include encouraging densely filled landscape spaces helping to minimize volunteer weeds and invasive species.

GOAL NO. 3 - PRESERVE NATURAL AREAS

INVASIVE SPECIES ERADICATION

GOAL INTENT

Preserve natural areas owned by the university, such as prairie or wetlands, through restoration efforts and keep them free of non-indigenous plant species.

PROCEDURE

Identify natural areas for preservation efforts. Within these natural areas identify invasive species for future removal. As resources allow, remove invasives and promote resilience within the ecosystem by planting native plants which can prevent invasive species from establishing.

RELATED REFERENCES

The Purdue University Physical Facilities Consultant's Handbook includes a list of invasive species prohibited on campus in Guidelines by CSI Division – Item 109 - CSI# 32 9300 Exterior Undesirable Plants.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 incentivizes the preservation of "6 plant communities native to the ecoregion of the site to contribute to regional diversity of flora and provide habitat for native wildlife" under Credit 4.8: Preserve Plant Communities Native to the Ecoregion.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 5.1 addresses protection and restoration of habitat in conjunction with building development. Sustainable Sites Credit 5.2 can be achieved by protecting an off-site natural area equal in size to the building footprint for the life of the building. Purdue has achieved this credit on a number of projects by setting aside tracts of forested land in McCormick Woods.

⁶ The Sustainable Sites Initiative, The Sustainable Sites Initiative: Guidelines and Performance Benchmarks, 2009, p. 111.



Peterson Prairie (Image courtesy of Jim Beatty)

CAMPUS CASE STUDY

The Peterson Prairie is a renovated prairie located at the Purdue Agronomy Center (www.ag.purdue.edu/agry/acre/Pages/peterson.aspx). It is an approximately four-acre plot containing native prairie plant species. It represents the junction where the Grand Prairie met the Great Hardwood Forest; it is the tip of the larger continuous prairie. The site contains two very different soil types, the darker prairie soil and the lighter forest soil. The site is used as an educational installation demonstrating the history of Indiana prairies and the plants that grew there.

The Agronomy Department renovated this plot in 2003 and continues to protect it from invasive plant species. Once a year the plot is burned allowing the native species to grow back and continue to be dominant. The dominant native species is "Big Blue Stem", a larger prairie grass that can grow to eight feet in height. Nearby, plots of native wildflowers are maintained to teach others how to identify those flowers and plants. Invasive plants are spot controlled by removal or spot spray.

GOAL NO. 5 - INCORPORATE THE STUDY OF INVASIVE SPECIES INTO THE CURRICULUM

INVASIVE SPECIES ERADICATION

GOAL INTENT

Incorporate studies of invasive species into biology, botany, and ecology classes and fieldwork. When possible, offer these classes to students in various departments, such as landscape architecture or design.

PROCEDURE

Work with appropriate faculty in Biology, Ecology, Forestry and Natural Resources, Horticulture and Landscape Architecture, and Botany to incorporate course content which highlights the dangers invasive species present to eco-systems. Learning objectives should include a working knowledge of invasive species, adapted species, native species, integrated pest management, and control / management techniques.

RELATED REFERENCES

The Purdue Arboretum (www.purdue.edu/buildings_grounds/trees/website/) supports the continued implementation of native plants in the area bound by State Street, Agricultural Mall, University Street, and Marsteller Street. This area was identified as a future destination garden for showcasing the use of native plants in traditionally ornamental applications. Native planting in this area is supported by the natural resources faculty in nearby buildings.

The Purdue University Physical Facilities Consultant's Handbook includes a list of invasive species prohibited on campus in Guidelines by CSI Division – Item 109 - CSI# 32 9300 Exterior Undesirable Plants.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the use of “plants that are non-invasive and appropriate for site conditions, climate, and design intent to improve landscape performance and reduce resource use” under Prerequisite 4.2: Use Appropriate, Non-Invasive Plants. Credit 4.2: Use Native Plants incentivizes the use of plant species native to the ecoregion.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 5.1: Site Development – Protect or Restore Habitat incentivizes the installation of native or adapted vegetation on previously developed sites to restore habitat and promote biodiversity.

Indiana Department of Natural Resources (IN DNR) maintains Invasive Species Assessments for plants IN DNR has deemed to be invasive species (<http://www.in.gov/dnr/4619.htm>).

CAMPUS CASE STUDY

These Purdue University courses are a sampling of courses which contain content relating to invasive species:

BIOL 483 Conservation and Environmental Biology

Applying ecological principles to conservation issues such as population viability and maintenance of diversity and ecosystem services.

BIOL 585 Ecology

Fundamentals of ecological theory and practice, with laboratory including field experiences.

BIOL 591 Field Ecology (cross-listed in Botany)

Testing ecological principles in real ecosystems, with emphases on biological diversity and individual research projects.

FNR 488 Global Environmental Issues

Threats to soil productivity, the changing atmosphere, water quality and quantity, energy impacts, and biodiversity from an ecosystem perspective.

HORT 217 Wood Landscape Plants

Recognition and identification of woody landscape plants; plant characteristics in terms of landscape function.

HORT 442 Sustainability in the Managed Landscape

Presents recent advances in the science and technology of sustainable practices for managed landscapes.

LA 227 Planting Design I

Review of design principles as related to plant design characteristics; design implications of plant responses to environment; review of landscape plants in fall.

LA 325 Planting Design II

Study of plants as unique elements of landscape design. Plants will be studied for their aesthetic and functional uses in the landscape. Various scales of planting and design will be approached. Natural distribution and ecological considerations in planting design will be explored. Incorporates class trips.

Landscape Architecture students are also required to conduct a sustainability analysis of existing plant compositions and of their own design proposals.

GOAL NO. 6 - MAINTAIN CONTROL WITH MORE FREQUENT ASSESSMENTS

INVASIVE SPECIES ERADICATION

GOAL INTENT

Keep invasive species under control by conducting annual, or more frequent, assessments to determine the best way to remove or prevent the spread of these troublesome species.

PROCEDURE

Regularly review plant databases and updated invasive species lists in conjunction with regular site visits. Inspect site work, to review the status of existing, encroaching, or new invasive and non-desirable plants. Visit and assess locations throughout the seasons for increased perspective. When managed to a thriving condition, plants that are desired can help reduce and eliminate invasive species. Additionally, covering exposed soil with mulch helps to reduce opportunities for undesirables to take hold.

RELATED REFERENCES

The Purdue University Physical Facilities Consultant's Handbook includes a list of invasive species prohibited on campus in Guidelines by CSI Division – Item 109 - CSI# 32 9300 Exterior Undesirable Plants.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the development and implementation of a management plan for “the control and subsequent management of known invasive plants found on site to limit damage to local ecosystem services.”⁷

The Sustainable Sites Initiative also requires the development of a sustainable landscape maintenance plan under Prerequisite 8.1: Plan for Sustainable Site Maintenance which includes criteria for identifying, monitoring, management, and removal of invasive plant species.

⁷ The Sustainable Sites Initiative, The Sustainable Sites Initiative: Guidelines and Performance Benchmarks, 2009, p. 88.



Students Working Near Smalley Center

CAMPUS CASE STUDY

University Residences employs and instructs students of the habits of native, non-invasive, and invasive plants. An example of common removal effort is that of typical garden weeds. Students are shown what to look for, including leaves, flowers, seeds, and overall plant structure, including the root system. Hand removal of weeds utilizing tools is a preferred method. These techniques are used system-wide.



NATIVE PLANT SPECIES SELECTION

GOAL NO. 1 - LANDSCAPE DISRUPTED AREAS WITH ONLY NATIVE SPECIES

NATIVE PLANT SPECIES SELECTION

GOAL INTENT

Landscape areas disrupted by construction or renovation projects with only native tree, flower, and shrub species. Natives are better adapted to Indiana's climate and important for wildlife.

PROCEDURE

Consider the exclusive use of native plants for all future landscape renovation and new construction projects. Where native plants are unable to perform necessary functions or provide desired aesthetic outcomes, utilize non-invasive plant species.

RELATED REFERENCES

The Purdue Arboretum (www.purdue.edu/buildings_grounds/trees/website/) supports the continued implementation of native plants in the area bound by State Street, Agricultural Mall, University Street and Marsteller Street. This area was identified as a future destination garden for showcasing the use of native plants in traditionally ornamental applications. Native planting in this area is supported by the natural resources faculty in nearby buildings.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 requires the use of "plants that are non-invasive and appropriate for site conditions, climate, and design intent to improve landscape performance and reduce resource use"⁸ under Prerequisite 4.2: Use Appropriate, Non-Invasive Plants. Credit 4.2: Use Native Plants incentivizes the use of plant species native to the ecoregion.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 5.1: Site Development – Protect or Restore Habitat incentivizes the installation of native or adapted vegetation on previously developed sites to restore habitat and promote biodiversity.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 5: Site Development – Protect or Restore Habitat also incentivizes the installation of native or adapted vegetation on previously developed sites to restore habitat and promote biodiversity.

⁸ The Sustainable Sites Initiative, [The Sustainable Sites Initiative: Guidelines and Performance Benchmarks](#), 2009, p. 90.



First Street Towers Native Landscape

CAMPUS CASE STUDY

Purdue is utilizing native plant species around new construction projects as well as current landscaping projects. The area around Pfendler Hall was replanted entirely with native plant species. Additionally, the area around the new residence hall, First Street Towers, has been landscaped with a predominance of native plant species.

First Street Towers utilizes a large numbers of native plants for its landscape. Designers made use of native tree species such as Sugar Maple, Sweet Gum, Black Gum, Ironwood, Red Oak, Serviceberry, Redbud and Hawthorn. The native shrubs used included Fothergilla, Sweetspire, and Dwarf Hemlock. The native grasses included Pennsylvania Sedge, Deschampsia, Little Bluestem, and Prairie Dropseed. Two species of native ferns were utilized, Lady Fern and Christmas Fern. Three types of native perennials were planted: Butterfly Weed, Tall Coneflower, and Goldenrod.

GOAL NO. 3 - PLANT NATIVE SPECIES ALONG ROADWAYS

NATIVE PLANT SPECIES SELECTION

GOAL INTENT

Plant native species along roadways and parking lots as filter strips to reduce toxic runoff from paved areas. Include native trees in your design to improve air quality and offer shade.

PROCEDURE

Prioritize the use of filter strips planted with native species to allow runoff from paved areas to infiltrate into the soil prior to, or as an alternative to, directing it into storm sewers. Utilize biosoil mixtures approved by the Senior Civil Engineer and Senior Landscape Architect. Local biosoils will have pH in the 7.0 – 8.0 range. Specify plants which tolerate this pH level. When stormwater exceeds the infiltration capacity of rain gardens and bioswales, it should be directed into underground storage or storm sewers. Overflow inlets leading to underground storage must be protected to prevent floating mulch materials from entering. This can be achieved by the temporary use of filter fabric at the inlets or by using geotextile mats in lieu of wood based mulch material.

RELATED REFERENCES

Filter strips have been installed to receive stormwater runoff from parking lots near the Armory, Black Cultural Center, Pao Hall and Ross Ade Stadium.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 6.1 and 6.2 incentivize the use of on-site stormwater infiltration. These credits encourage designing rain gardens, vegetated infiltration swales, retention ponds, and vegetated filter strips to minimize stormwater runoff volume and to remove contaminants from stormwater on project sites.

Purdue University Campus-Wide Sustainable Stormwater Modification Design – November 2009 is the stormwater masterplan for the West Lafayette campus. It is an analysis of existing stormwater infrastructure and a guide to the ecological and environmental stewardship of Purdue's water resources.

Purdue Physical Facilities Consultant's Handbook includes the following documents regarding stormwater management on campus:

- Comprehensive Stormwater Management Ordinance of Purdue University
- Purdue University Stormwater Technical Standards Manual
- List of Post-construction BMP Appendices (includes information specific to vegetated stormwater infiltration interventions)



Ross Ade Stadium Parking Lot Bioswale During Rain Event

CAMPUS CASE STUDY

The Ross Ade Stadium bioswale is the most sophisticated stormwater best management practice on campus. On the high western edge of the lot, a porous asphalt parking area begins the process of mitigating runoff. Water is then collected in a bioswale at the eastern side of the parking lot where it is encouraged to infiltrate into the soil. When it exceeds the soil's infiltration capacity it overflows into infiltration beds beneath two outdoor football practice fields nearby. If those beds reach capacity, excess stormwater is then directed into storm sewers. Designing the system in this way removed a significant amount of stormwater runoff from storm sewers which previously hastened it to Harrison Pond south of campus.

The Ross Ade bioswales also utilize native plant species. The bioswale on the east side of the parking lot includes American Hornbeam, Paper Birch, Shrub Dogwood, St. Johnswort, Snowberry, Ninebark, Little Bluestem, Bluejoint grass, Tufted Hair Grass, Hair Grass, Gayfeather, Switch Grass, and Purple Coneflower.

GOAL NO. 4 - PROVIDE RIPARIAN BUFFERS NEAR LAKES AND STREAMS

NATIVE PLANT SPECIES SELECTION

GOAL INTENT

Install native plants, especially tall grasses, near lakes and streams to provide a natural buffer. Riparian buffers should be at least 35 feet wide; whereas herbaceous filter strips for areas prone to soil erosion should be 20 feet wide. Buffers also deter nuisance wildlife, such as Canadian geese.

PROCEDURE

Riparian buffers at least thirty-five (35) feet wide should be planned adjacent to lakes, ponds, and streams. This will help limit the transport of sediment, nitrogen, and phosphorous into adjacent water bodies. It will also establish a riparian zone in which natural stream geomorphology and wildlife travel corridors can occur. Twenty foot (20) wide herbaceous filter strips should be planned for areas prone to soil erosion. Native plant species and communities should be utilized wherever possible.

Harrison Pond and a variety of smaller ponds occur in the former gravel pit area, south of Harrison Street and the airport. Several ponds occur on campus golf courses. Tributary streams originate along Cherry Lane and at the Northwest Athletic Facility. Care should be taken to avoid plantings which attract wildlife which poses a threat to flights in and out of the Purdue Airport.

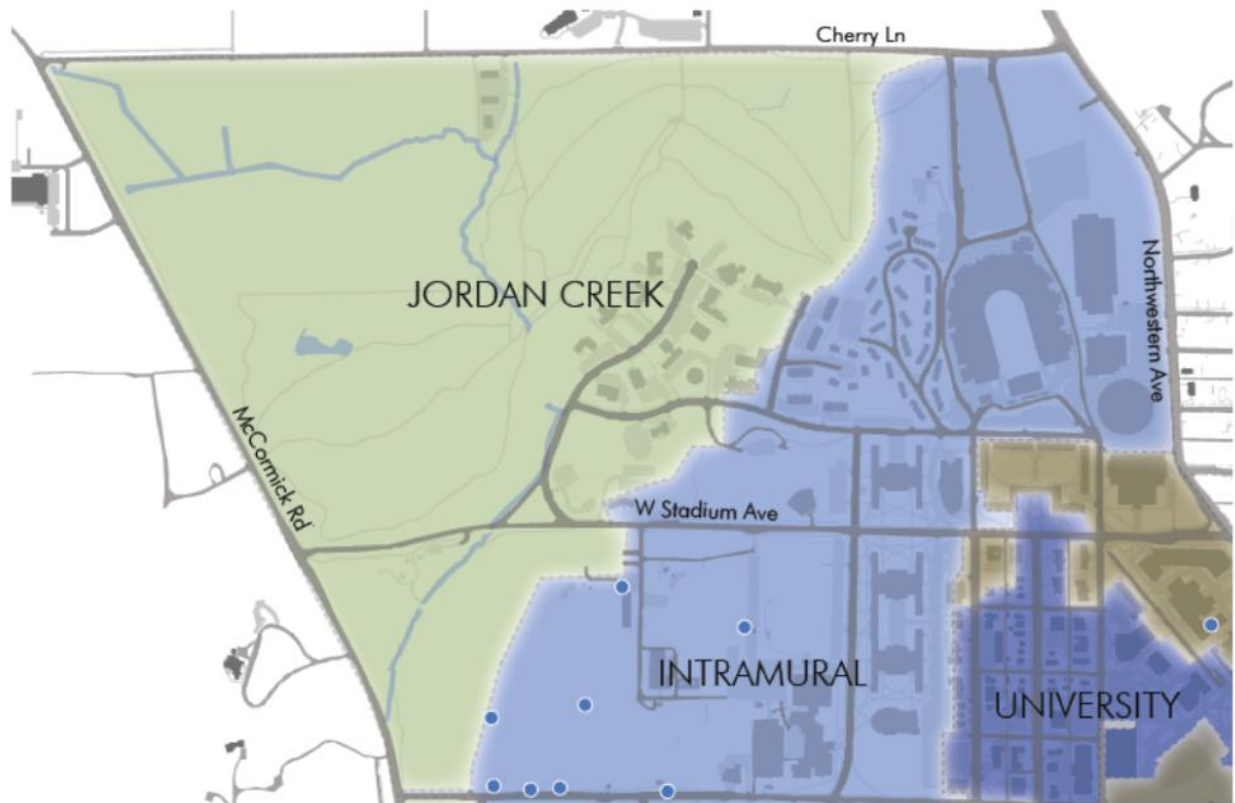
RELATED REFERENCES

The Purdue University Airport Wildlife Hazard Management Plan – May 2011 addresses the management of wildlife which poses a threat to aviation activities in the vicinity of the facility. A variety of planting issues are addressed.

Purdue University Campus-Wide Sustainable Stormwater Modification Design – November 2009 is the stormwater masterplan for the West Lafayette campus. It is an analysis of existing stormwater infrastructure and a guide to the ecological and environmental stewardship of Purdue's water resources.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 incentivizes the preservation and enhancement of riparian buffers "to improve flood control and water quality, stabilize soils, control erosion, and provide wildlife corridors and habitat"⁹ under Credit 3.3: Protect and Restore Riparian, Wetland, and Shore Buffers.

⁹ The Sustainable Sites Initiative, The Sustainable Sites Initiative: Guidelines and Performance Benchmarks, 2009, p. 57.



Campus Stormwater Watershed Map Showing the Unnamed Tributary and its Watershed (in green, mislabeled Jordan Creek).

CAMPUS CASE STUDY

Purdue Campus Planning is planning to develop riparian buffers for the Unnamed Tributary (it feeds into the Wabash River) on the northwest intramural / athletic fields of campus. This area is being looked at for a riparian buffer because of erosion issues as well as issues with runoff collected from non-campus sources. The unnamed tributary receives run off from the neighborhood north of campus, above Cherry Lane, as well as runoff from the golf courses. The athletic fields are at the top of two watersheds on campus, the intramural and university watershed zones. The unnamed tributary project will be part of ongoing projects to manage runoff along Tower Drive and the golf courses.

The university has reached out to the neighborhood north of campus as well as the Wabash River Enhancement Corporation (www.wabashriver.net/workshops/) to work on managing runoff both on and off campus stormwater. In this manner, runoff can be managed and erosion controlled for much of the unnamed tributary, thereby maintaining its overall integrity.



**WATER CONSERVATION,
RETENTION, & RECYCLING**

GOAL NO. 1 - WATER ONLY WHEN NECESSARY

WATER CONSERVATION, RETENTION, AND RECYCLING

GOAL INTENT

Water turf-grass and plants only when necessary, preferably in the morning. Use in-ground moisture valves to determine when your landscape requires water. Watering in the afternoon can lead to evaporation, whereas watering at night encourages fungus growth in lawns and beds.

PROCEDURE

In order to minimize use of water in irrigation, it is important to know what kind of soil is present in the area being water. Some areas of campus will be primarily clay and others may be made up of sandy soils. Each area requires a different amount of water to be effectively irrigated.

Use soil sensors to determine the right time to water. Know which plant types are being watered as well as how much moisture each plan requires. The soil that the plant is in will also play a role in how much water to use.

Water plants and turf-grass early in the day. If areas need to be watered later in the day, know the conditions outside. Plants may be watered in the evening, for example, if there is a breeze and low humidity. Otherwise, focus on watering early to avoid evaporation.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 incentivizes the reduction of water used for irrigation under Credit 3.2 – Reduce Potable Water Use for Landscape Irrigation by 75 Percent or More from Established Baseline.

LEED 2009 for New Construction and Major Renovations Water Efficiency Credit 1: Water Efficient Landscaping incentivizes the reduction of water used for irrigation; irrigation efficiency is included as an appropriate technology.

LEED 2009 for Existing Buildings: Operations and Maintenance Water Efficiency Credit 3: Water Efficient Landscaping incentivizes the reduction of water used for irrigation; irrigation efficiency is included as an appropriate technology.



Purdue University Campus – Centennial Mall

CAMPUS CASE STUDY

Purdue Grounds and Maintenance prides itself on keeping up with current technologies to reduce water use for irrigation. Grounds and Maintenance utilizes new irrigation heads to better target areas that need water. Unlike older sprinkler systems, the newer irrigation heads come in a variety of angles, as opposed to just forty-five and ninety degree spray heads. Thirty-degree nozzles are used to cover target areas. Less water is wasted on sidewalks and other surfaces that do not require water.

Grounds and Maintenance uses irrigation heads that keep water from drifting. The irrigation head produces droplets of water instead of steady stream. This prevents the stream from drifting as much as older conventional irrigation heads. Water is kept on the target plant material as opposed to drifting onto surfaces that do not require watering. These measures, combined with a much better selection of nozzles for corners of the sidewalks and other impervious areas, ensure that the maximum amount of irrigation is delivered to the proper area.

GOAL NO. 2 - INSTALL TIMERS ON SPRINKLER SYSTEMS

WATER CONSERVATION, RETENTION, AND RECYCLING

GOAL INTENT

Install timers or quick shut-off valves on sprinkler systems to conserve water.

PROCEDURE

Determine what specifications are desirable for the sprinkler system. Sprinkler timers can be installed in each zone of the system.

Install 'Smart Clocks' along with the sprinkler timers. These timers should also have a rain gauge and soil probes to help determine what areas need water and how much. Soil probes by themselves are not very reliable. Paring these systems together can increase reliability and conserve water used for irrigation.

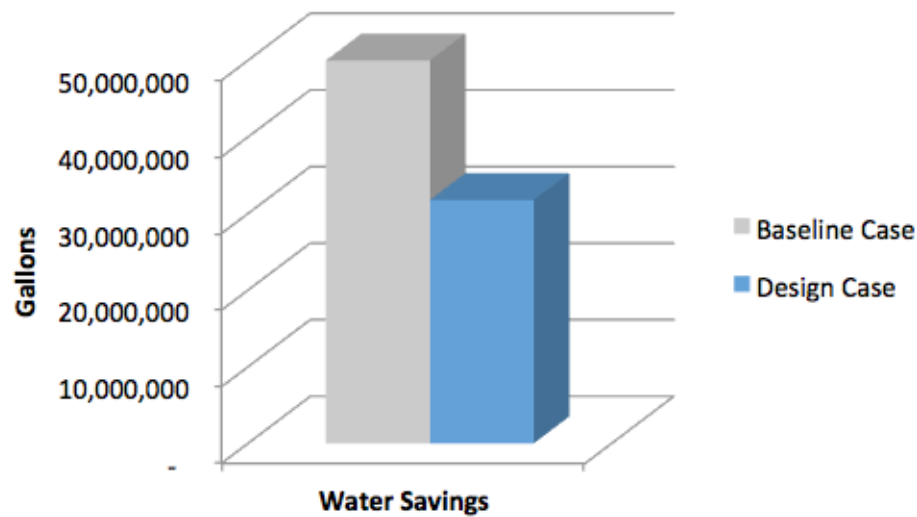
Install a weather interface, or computer control system to coordinate sprinkler timers. This will allow remote activation and setting of timers as well as greater control and precision for irrigation.

RELATED REFERENCES

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 incentivizes the reduction of water used for irrigation under Credit 3.2 – Reduce Potable Water Use for Landscape Irrigation by 75 Percent or More from Established Baseline.

LEED 2009 for New Construction and Major Renovations Water Efficiency Credit 1: Water Efficient Landscaping incentivizes the reduction of water used for irrigation; irrigation efficiency is included as an appropriate technology.

LEED 2009 for Existing Buildings: Operations and Maintenance Water Efficiency Credit 3: Water Efficient Landscaping incentivizes the reduction of water used for irrigation; irrigation efficiency is included as an appropriate technology.



Projected savings based off the implementation of the central control system

CAMPUS CASE STUDY

The Grounds Department at Purdue has been keeping up with technology since the 1950s to more efficiently and effectively keep campus grounds lush and green. Since the 1970s, the department has integrated clocks with the irrigation systems for better control. Since the early 2000s, smart clocks, soil probes, and rain gauges have been used for even more precision and conservation. The department is responsible for over 1.9 million square feet of turf and over 680,000 square feet of shrub and flowerbeds. The irrigation systems on campus contain 67 control units and over 600 in-ground control valves, as well as more than 10,000 irrigation heads.

The Grounds Department is now implementing a new central control system. Before the implementation of this system, grounds staff would have to set the control units manually. With the new system, this may all be done remotely. This system also incorporates weather data to help determine how much water is required. Projections indicate that there will be a 36% reduction in water usage. Current usage is estimated at approximately 49 million gallons of irrigation water being reduced to approximately 31 million gallons of water used for irrigation.

GOAL NO. 4 - BUILD RAIN GARDENS AND BIOSWALES

WATER CONSERVATION, RETENTION, AND RECYCLING

GOAL INTENT

Build rain gardens and vegetated bioswales to slow stormwater runoff, filter chemicals, and control erosion. Redesigning areas of turfgrass and impervious surface can help keep water on the property longer, recharge groundwater resources, and decrease the frequency or severity of sewer overflow events.

PROCEDURE

Prioritize the use of rain gardens and bioswales to clean and infiltrate stormwater from paved surfaces and building roofs, especially in areas where stormwater is currently directed into combined storm/sanitary sewers. Locate rain gardens and bioswales no closer than 10 feet from buildings and give special consideration to nearby basements and tunnels with leak problems. When stormwater exceeds the infiltration capacity of rain gardens and bioswales, it should be directed into storm sewers.

RELATED REFERENCES

Bioswales have been installed at Mann Hall in Discovery Park, at Pao Hall of Visual and Performing Arts and in parking lots near the Armory and Ross Ade Stadium. Rain gardens will soon be installed at the Horticulture Building and in the plaza just northeast of Harrison Hall.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 6.1 and 6.2 incentivize the use of on-site stormwater infiltration. These credits encourage designing rain gardens, vegetated infiltration swales, retention ponds, and vegetated filter strips to minimize stormwater runoff volume and to remove contaminants from stormwater on project sites.

Purdue University Campus-Wide Sustainable Stormwater Modification Design – November 2009 is the stormwater masterplan for the West Lafayette campus. It is an analysis of existing stormwater infrastructure and a guide to the ecological and environmental stewardship of Purdue's water resources.

Purdue Physical Facilities Consultant's Handbook includes the following documents regarding stormwater management on campus:

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A Bioswale (left) Collects Parking Lot Runoff Near Pao Hall of Visual and Performing Arts

CAMPUS CASE STUDY

Purdue staff strive to help protect and improve the quality of underground water resources and to continue to execute the University's comprehensive campus storm water management program. Campus storm water treatments include bioswales, permeable pavement and pervious concrete, rain gardens, infiltration beds and green roofs. Bioswales are located on the grounds of Pao Hall of Visual and Performing Arts, Bindley Bioscience Center, Ross-Ade Stadium, Mollenkopf Athletic Center and the Armory parking lot.

The Pao Hall bioswales were the first true bioswales on campus. A consultant designed the bioswales as an economical and more attractive alternative to curbs and gutters. A dense planting of native grasses and forbes were surrounded by cultivated shrubs and trees which helped the looser native plants better fit into the campus landscape context.

GOAL NO. 5- USE PERVIOUS SURFACES

WATER CONSERVATION, RETENTION, AND RECYCLING

GOAL INTENT

Use pervious surfaces (paving stones, pervious concrete, porous asphalt) to reduce the amount of surface water runoff, which can collect nutrients and toxins from entering rivers and creeks. Reducing runoff will help alleviate stress on aquatic life.

PROCEDURE

Look for opportunities to install pervious surfaces during the design of building construction projects, landscape projects and parking surfaces,. After evaluating each site as to how the project effects or creates runoff, determine/design the best system to mitigate or control runoff. Infiltrating this runoff allows the natural filtration of storm water impurities through the soil profile, instead of adding these impurities to local Harrison Pond and combined municipal sewers. Methods implemented should align with the University Campus-wide Sustainable Storm Water Modification Design.

RELATED REFERENCES

The Purdue University Campus-wide Sustainable Stormwater Modification Design (2009) recommends pervious hardscape as a Structural Best Management Practice (BMP) as a component of a comprehensive, sustainable approach to sustainable stormwater management.

The Sustainable Sites Initiative: Guidelines and Performance Benchmarks 2009 incentivizes the use of pervious pavements and other stormwater best management practices under Credit 3.5 – Manage Stormwater On Site. This credit distinguishes amongst site contexts for criteria for greenfield, greyfield, and brownfield sites, and quantifies post development water storage capacity of a site.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 6.1: Stormwater Design – Quantity Control and Credit 6.2: Stormwater Design – Quality Control both incentivize the utilization of stormwater best management practices to mitigate the effects of post-development stormwater runoff.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 6: Stormwater Quantity Control also provides credit for the utilization of stormwater best management practices to mitigate the effects of post-development stormwater runoff.



Permeable Pavement at the Black Cultural Center Parking Lot

CAMPUS CASE STUDY

In 2007, permeable pavement (also known as porous asphalt) was first installed at the Horticulture Service Drive. Permeable pavement allows water to drain through it, reducing storm water runoff and pollutants. Other campus sites with permeable pavement include Beering Drive and the band practice field. In addition to permeable pavement, pervious concrete has been installed at the parking lot north of the Armory, Marriott Hall and at the intersection of Third and Russell streets.

Permeable pavement was most recently used in the Black Cultural Center (BCC) parking lot. This is Purdue's most successful use of permeable pavement. The pavement was used in the parking stalls of the lot to infiltrate runoff. The parking lot was graded so that runoff not infiltrating the porous asphalt would collect at a bioswale in the center. The central bioswale was surrounded by impervious concrete pavement to keep debris and particulates from clogging the porous asphalt. This was a lesson learned from other pervious pavement installations where porous paving at low points collected sediment and clogged. Excess runoff was then directed into another bioswale at the north end of the parking lot.

GOAL NO. 6 - INSTALL VEGETATED ROOFS

WATER CONSERVATION, RETENTION, AND RECYCLING

GOAL INTENT

Install a vegetated “green roof” on suitable buildings to mitigate stormwater runoff and the effect of heat islands. Depending on the frequency of rainstorms and amount of precipitation, this type of roof can retain a large amount of stormwater runoff. The additional heat from dark roofs can contribute to an increase in water temperature, affecting wildlife species’ metabolism and reproduction. Other benefits of green roofs include reductions in energy use, air pollution from emissions, and human health risks.

PROCEDURE

Screen future roof replacement projects and new construction / major addition projects for the applicability of green roofing systems. The weight of green roofing systems must be evaluated structurally. Develop a project screening methodology for assessing / evaluating green roof projects on campus. This assessment is especially critical in the University CSO (Combined Sewer Overflow) drainage area (as defined by the Purdue University Campus-wide Sustainable Stormwater Modification Design); priority should be given to green roof projects within the University CSO area. Careful consideration should be given to roofing warranty issues (i.e. is the roofing system and the plant media installed and/or warranted by the same contractor or multiple contractors). Purdue should continue to promote green roofs on campus through green roof tours and case study presentations.

RELATED REFERENCES

The Purdue University Campus-wide Sustainable Stormwater Modification Design (2009) recommends green roofs as a Structural Best Management Practice (BMP) as a component of a comprehensive, sustainable approach to sustainable stormwater management.

LEED 2009 for New Construction and Major Renovations Sustainable Sites Credit 7.2: Heat Island Effect – Roof incentivizes the installation of vegetated roofs to reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.

LEED 2009 for Existing Buildings: Operations and Maintenance Sustainable Sites Credit 7.2: Heat Island Effect – Roof provides credit for installing green roofs on existing buildings.

Gall, H., Schuster, D., Jafvert, C., Rhoads, W. “Design, Implementation, and Monitoring of Purdue University’s First Green Roof.” International High Performance Buildings Conference. West Lafayette, IN. July 2010.



Schleman Hall Green Roof Project

CAMPUS CASE STUDY

Boiler Green Initiative (BGI), a student organization, received a grant from State Farm to build Purdue's first green roof (also the first green roof in Tippecanoe County). The Schleman Hall Green Roof Project, constructed in the spring of 2009, was a retrofit of an existing 1,750 square foot roof with a modular, extensive system. The purpose of this student-led project was to make Schleman Hall more energy efficient, environmentally responsible, and aesthetically pleasing, to extend the life of the roof membrane, and to introduce environmentally friendly practices to students and the community. The installation also acts as a 'living laboratory' for various studies on green roofs including energy efficiency, insect populations attracted to green roofs, and stormwater capture/treatment.

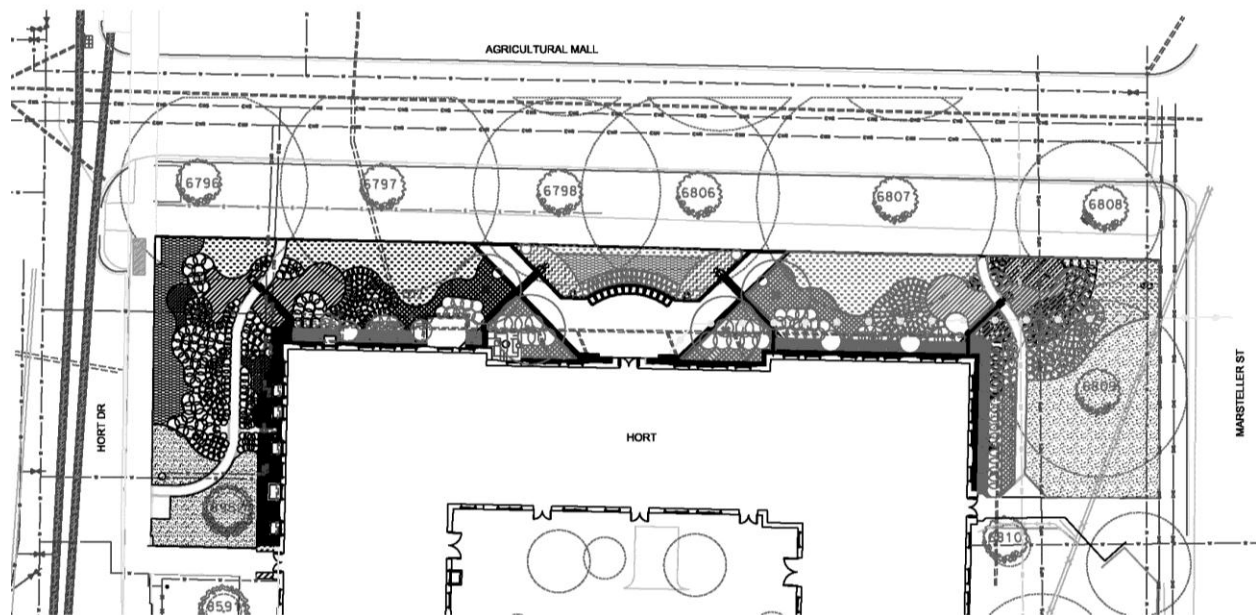
One of these studies, Design, Implementation, and Monitoring of Purdue's First Green Roof (2010), determined that the plant material mitigated the temperature extremes of the membrane surface; the membrane was warmer in winter and cooler in summer. Mitigation of membrane temperature extremes was known to extend the lifespan of the roofing membrane by as much as three times. This study also calculated that as much as 80% of rainfall would be retained by the green roofing system. Data collection and analysis of the Schleman Hall Green Roof Project continues.



**IMPLEMENTATION OF
NEW PROJECTS**

HORTICULTURE BUILDING RAIN GARDEN, FALL 2012

The Horticulture Building rain garden was initiated as a result of the Campus-wide Sustainable Stormwater Modification Design (2009). When asked to identify BMPs in the Agricultural Mall area, consultants recommended daylighting exterior downspouts and redirecting stormwater into the soil near the building. Strategic infrastructure funding of \$100,000 was directed toward the project. Campus Planning staff engaged faculty and students in Purdue's Landscape Architecture Program to develop conceptual design ideas for the rain garden. Upon review, these ideas were refined into a design which used concrete runnels to bring stormwater from downspouts to walkways where pedestrians could engage it on its way to adjacent rain gardens. A porous concrete paver entry plaza with seating was surrounded by rain garden plantings which included a variety of native and non-native plants capable of withstanding 24 hour inundation. Faculty in Horticulture and Landscape Architecture provided design review and input on plant selection and garden form. The rain garden will bring a number of features to the building which can be utilized in coursework for teaching students in both the horticulture and landscape architecture programs.



Design Plan of Horticulture Building Rain Garden

HARRISON PLAZA RAIN GARDEN, FALL 2012

The student organization, Boiler Green Initiative (BGI), studied several locations on campus for a demonstration rain garden aimed at heightening awareness of this stormwater best management practice. The Harrison Plaza area was selected after discussions with Campus Planning and Residence Halls administration. Infiltration at the site was slow which caused surface runoff to back up on sidewalks and then enter storm sewer drain inlets. The site's location between several high-rise dormitories made it desirable from a public education perspective. BGI secured grants to fund the project from a variety of sources including the Wabash River Enhancement Corporation. BGI will be directly involved in rain garden design, installation and maintenance. Purdue staff from Physical Facilities, Residence Halls and Campus Planning will provide assistance. The rain garden will incorporate native plants. BGI will also develop interpretive signage to educate the public about the rain garden.



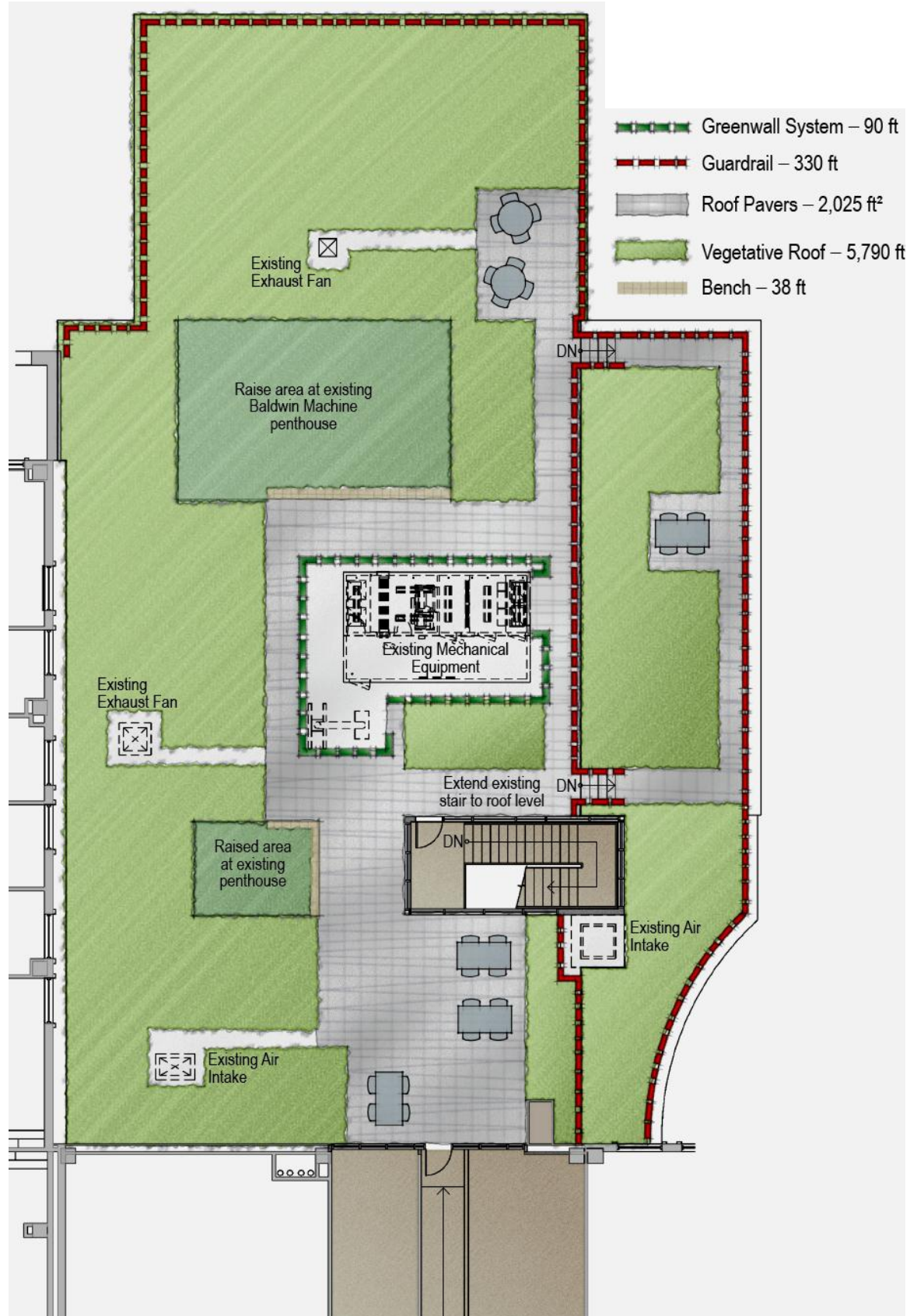
Harrison Plaza existing condition

CIVIL ENGINEERING GREEN ROOF PROJECT, MARCH 2012

The Civil Engineering Green Roof Project was initiated two years by the Civil Engineering Student Advisory Council. The original goal was to provide a gathering space for students while providing opportunities for the School to demonstrate the sustainability and green initiatives that they are learning about in many of their classes. Over the last two years the students have raised more than \$125,000 toward the project with proceeds from their annual CE Career Fair. The School of Civil Engineering, their alumni, industrial partners, and R&R funding from Purdue have provided the balance of the \$850,000 project.

The School of Civil Engineering's mission includes providing an exceptional educational experience for our undergraduate students. Our undergraduate curriculum includes many laboratories. It is critical that our students are exposed to state-of-the art facilities with updated equipment. The addition of a green roof to the Civil Engineering Building will introduce this new technology to our students and will allow them to participate in research on energy reducing technologies in the building. With our new architectural engineering program, this unique facility is an important component of the new curriculum. Our students and faculty in the architectural engineering and environmental areas will collaborate to develop methods for sustainability testing and modeling in "real world" settings. This will be achieved by using the pavers and plant medium on the new roof to study heat loads of the roof structure and investigate energy reducing technologies for the building. They will also investigate the impact of a rainwater collection system for the green roof.

This green roof project is the final piece of the contiguous learning space created by the recent Lyles Ideas to Innovation, Pankow Materials, and Burke Hydraulic/Hydrology Lab renovations and the newly completed Civil Engineering Research Garden. It is visually connected to these spaces and will provide an exterior testing space for green roof assemblies.



Rendered Plan of Civil Engineering Green Roof



APPENDIX A: CONSULTANT'S HANDBOOK
LIST OF UNDESIRABLE PLANTS

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Last Update: August 10, 2006

Undesirable Plants:

The following plants have characteristics or susceptibilities making them unsuitable for use on Purdue's West Lafayette campus. These plants should not be specified for use without special exception.

*These invasive plants are specified in standard erosion control specifications and should be removed from those specifications before inclusion in construction documents for the West Lafayette campus.

<u>Scientific Name</u>	<u>Common Name</u>	<u>Reason</u>
<i>Acer platanoides</i>	Norway Maple	Invasive
<i>Acer saccharinum</i>	Silver Maple	Weak Wood
<i>Ailanthus altissima</i>	Tree of Heaven	Invasive
<i>Alliaria petiolata</i>	Garlic Mustard	Invasive
<i>Alnus glutinosa</i>	Black Alder	Invasive
<i>Bromus inermis</i>	Smooth Brome	Invasive
<i>Celastrus orbiculatus</i>	Oriental Bittersweet	Invasive
<i>Cirsium arvense</i>	Canada Thistle	Invasive
* <i>Coronilla varia</i>	*Crown Vetch	Invasive
<i>Eleagnus umbellata</i>	Autumn Olive	Invasive
<i>Euonymous alatus</i>	Winged Spindle Tree	Invasive
<i>Euonymous fortunei</i>	Purple Winter Creeper	Invasive
* <i>Festuca elatior</i>	*Tall Fescue	Invasive
<i>Fraxinus spp.</i>	Ash	Emerald Ash Borer
<i>Ginkgo biloba</i> (female)	Female Ginkgo	Malodorous Fruit
<i>Glechoma hederacea</i>	Creeping Charlie	Invasive
<i>Gleditsia triacanthos</i>	Honeylocust	Insects, Diseases
<i>Hemerocalis 'Stella d'Oro'</i>	Stella d'Oro Daylilly	Overplanted
<i>Hemerocalis 'Happy Returns'</i>	Happy Returns Daylilly	Overplanted
<i>Hesperis matronalis</i>	Dame's Rocket	Invasive
<i>Humulus japonicus</i>	Japanese Hops	Invasive
<i>Imperata cylindrical</i> (from tissue culture)	Japanese Bloodgrass (from tissue culture)	Invasive
<i>Lespedeza bicolor</i>	Bicolor lespedeza	Invasive
<i>Lespedeza cuneata</i>	Sericea lespedeza	Invasive

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<u>Scientific Name</u>	<u>Common Name</u>	<u>Reason</u>
<i>Ligustrum vulgare</i>	Common Privet	Invasive
<i>Lonicera Japonica</i>	Japanese Honeysuckle	Invasive
<i>Lonicera maackii</i>	Amur Honeysuckle	Invasive
<i>Lonicera morrowii</i>	Morrow Honeysuckle	Invasive
<i>Lonicera tatarica</i>	Tartarian Honeysuckle	Invasive
<i>Lysimachia nummularia</i>	Creeping Jenny	Invasive
<i>Lythrum salicaria</i>	Purple Loosestrife	Invasive
<i>Malus spp.</i> (disease susceptible)	Disease Susceptible Crabapples	Apple Scab, Fire Blight, Powdery Mildew
<i>Melilotus alba</i>	Sweet Clover	Invasive
<i>Microstegium vimineum</i>	Japanese stilt grass	Invasive
<i>Miscanthus sinensis</i>	Maiden grass	Invasive
<i>Morus alba</i>	White Mulberry	Invasive
<i>Ornithogalum umbellatum</i>	Star of Bethlehem	Invasive
<i>Phalaris arundinacea</i>	Reed Canary Grass	Invasive
<i>Phragmites australis</i>	Common Reed or Phragmites	Invasive
<i>Pinus nigra</i>	Austrian Pine	Diplodia Tip Blight
<i>Pinus sylvestris</i>	Scotch Pine	Diplodia Tip Blight, Pine Wood Nematode
<i>Platanus occidentalis</i>	Sycamore	Litter
<i>Polygonum cuspidatum</i>	Japanese Knotweed	Invasive
<i>Pueraria lobata</i>	Kudzu	Invasive
<i>Pyrus calleryana</i> 'Bradford'	Bradford Pear	Weak Wood
<i>Quercus palustris</i>	Pin Oak	Iron Chlorosis
<i>Rhamnus cathartica</i>	Common Buckthorn	Invasive
<i>Rhamnus frangula</i>	Glossy Buckthorn	Invasive
<i>Robinia pseudoacacia</i>	Black Locust	Invasive
<i>Rosa multiflora</i>	Multiflora Rose	Invasive
<i>Salix x blanda</i>	Wisconsin Weeping Willow	Weak Wood, Cankers
<i>Sorbus spp.</i>	Mountain Ash	Borers, Cankers
<i>Tilia spp.</i>	Linden	Japanese Beetle
<i>Ulmus carpinifolia</i> 'Accolade'	Accolade Elm	Japanese Beetle
<i>Ulmus pumila</i>	Siberian Elm	Invasive

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<u>Scientific Name</u>	<u>Common Name</u>	<u>Reason</u>
<i>Viburnum opulus v. opulus</i>	Highbush Cranberry	Invasive
<i>Vinca minor</i>	Periwinkle	Invasive



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