LID AND LEED AT WETLAND STUDIES AND SOLUTIONS, INC.

THE RIGHT THING TO DO

In 2005, Wetland Studies and Solutions, Inc. (WSSI) built Virginia's first LEED gold certified facility. WSSI encourages building in an environmentally-conscious manner because they believe that "healthy state and local economies and a healthy Chesapeake Bay are integrally related; balanced economic development and water quality protection are not mutually exclusive[1]," and they work with developers to create projects that reflect this belief.

The building not only reduces potable water consumption by 50% and energy consumption by 35% but also mimics the hydrology of an undisturbed forest to reduce downstream degradation. Recycled and renewable materials, passive "green" building design, and high-tech solutions all help to create a vibrant work space for WSSI employees, simply because it's the right thing to do.

[1] Chesapeake Bay Preservation Act

LID

Rather than just being a patchwork of non-structural BMP's scattered throughout a site, **low-impact development** (LID) is a holistic stormwater management strategy that attempts to mimic predevelopment hydrology through: **conservation** of existing hydrologic features, **minimization** of impervious surfaces, maintaining the natural **direction** of water flow, multiple **small-scale controls, pollution prevention** during and after construction, and public **education.**

LEED

The **Leadership in Energy and Environmental Design** (LEED) Green Building Rating System® is a national standard for developing high-performance, environmentally-sustainable buildings. Developed by the U.S. Green Building Council (USGBC), LEED is a voluntary program that allows developers to set themselves apart as being environmentally-conscious in design, engineering, and construction.

For more information: http://www.usgbc.org

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Low Impact Development - *The WSSI Site Plan*

The WSSI site is serviced by a regional stormwater management pond, and no onsite stormwater management is required. To reduce stream degradation upstream of the regional pond, however, the low-impact site plan traps, slows, infiltrates, and reuses stormwater runoff in the same way an undisturbed, forested site would.

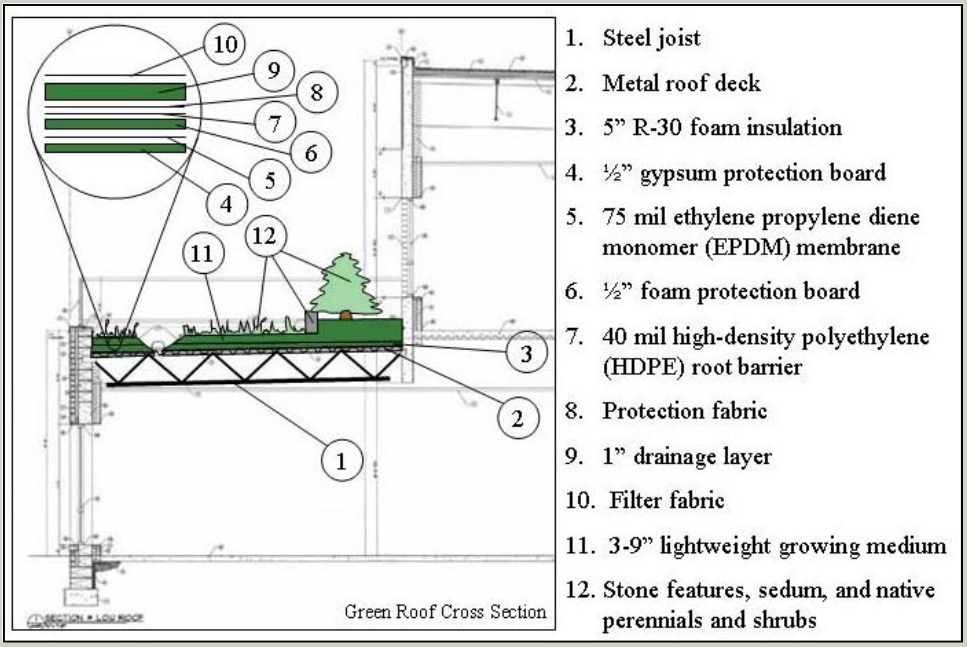
Stormwater runoff is often considered a nuisance rather than an asset, but WSSI's site plan captures the first half inch (or "first flush," which contains up to 90% of the total nutrient load) of roof runoff in a cistern for irrigation of the site's native landscaping and an additional quarter inch in a second cistern for reuse in the building's toilets. The site also reduces impervious surfaces by 28.8%; reduces the peak runoff rate 15.7% below the forested condition; and removes 51.3% of the phosphorous in the runoff.

The phrase "urban heat island" refers to the elevated temperatures around a city created by the large amounts of black asphalt used in roads and building roofs; with its reflective and green roofs, light-colored pervious surfaces, and extensive use of native vegetation, the site contributes very little to this problem.

WSSI's site is also a Certified Wildlife Habitat through a program run by the National Wildlife Federation, because its native landscaping provides food and shelter for a wide variety of insects, songbirds, aquatic animals, and mammals.

The following pages give a more detailed look at the low-impact techniques on our site.

Low Impact Development - *The Green Roof*



1. Steel joist
2. Metal roof deck
3. 5" R-30 foam insulation
4. ½" gypsum protection board
5. 75 mil ethylene propylene diene monomer (EPDM) membrane
6. ½" foam protection board
7. 40 mil high-density polyethylene (HDPE) root barrier
8. Protection fabric
9. 1" drainage layer
10. Filter fabric
11. 3-9" lightweight growing medium
12. Stone features, sedum, and native perennials and shrubs

Roof layers

The 3,626 square foot green roof adorns a single-story extension on the building's north and east sides and is accessible from the second-story training room. It is an extensive/ intensive hybrid with pathways, walls, seating patios, and two small wetland areas.

Extensive green roofs have a shallow (less than 4") soil layer and are planted with hardy plants such as sedums. Intensive green roofs have a thicker (greater than 4") soil base and are planted with perennials and shrubs. Some green roofs have very deep soil layers and are planted with trees to provide shade– we found this option intriguing but cost prohibitive.

The corrugated metal roof deck is covered in multiple layers of protection fabric, membranes, drainage, and root barriers beneath the lightweight soil (see above). While the intensive roof areas are planted with some native varieties (such as Carolina rose and prickly pear), the roof's climate is much hotter, drier, and windier than a typical local meadow, and the lightweight soil medium in the extensive areas has a low organic content. Therefore, the majority of the roof is covered in sedums, which are adapted to such a harsh ecosystem. The two wetland pods contain native sedges, rushes, and forbs, and are irrigated via a computerized system driven by a soil moisture sensor. Completed in early October 2005, the roof is a vibrant addition to WSSI's low-impact landscape.

Wetland and sedum areas, June 2006

Intensive and extensive zones, June 2006

EPDM layer atop R-30, Aug. 2005

Guard rail, September 2005

Roof drain, October 2005

Foam protection board, Oct. 2005

Placing the soil, Oct. 2005

The planted roof, Oct. 2005

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Roof drain trench, Sept. 2005

Cistern installation, Sept. 2005

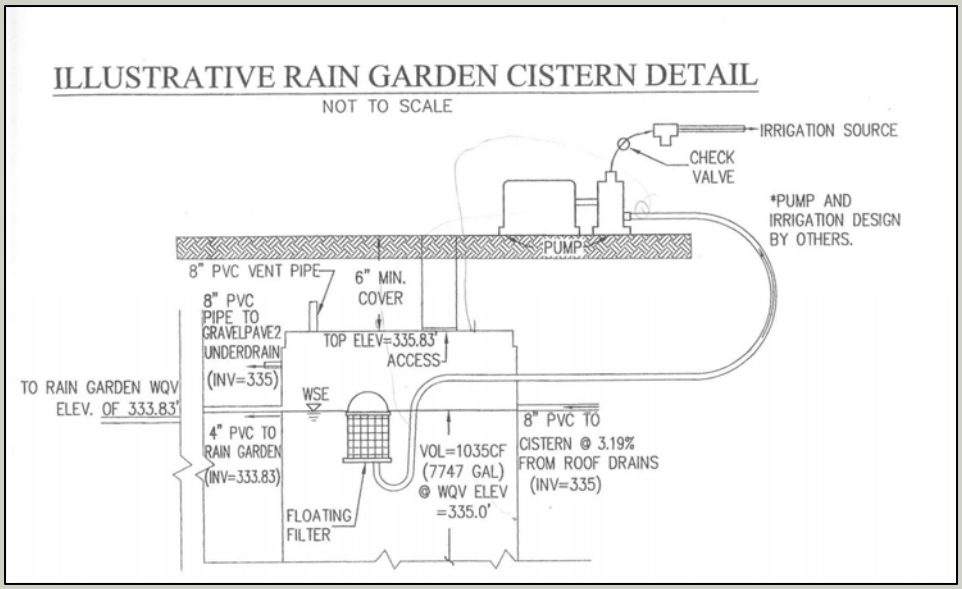
Rain garden pipes, Sept. 2005

Native Landscaping, 2006

Native Landscaping, 2006

Native Landscaping, 2007

Low Impact Development - *8,000 Gallon Cistern and Drip Irrigation*



Cistern Detail

Runoff from the building roof is directed to an 8,000-gallon underground cistern situated next to the rain garden. The water collects in the cistern, where it can be pumped into the drip irrigation system to water the site landscaping, thereby allowing the plants to utilize the nutrient loads from the runoff. When the cistern is full, it overflows to the rain garden, which then drains into to the gravel bed detention system.

The drip irrigation system is a network of flexible perforated pipe. Water is pumped through the pipe and drips slowly into the ground, where it nourishes the plants. Drip irrigation is more water-efficient than spray irrigation for two reasons. First, spray irrigation experiences an amount of evaporation due to the high velocities and small drops that are sprayed into the air. Second, the water from spray irrigation is not locally contained due to the nature of the system– some of the water is wasted on sidewalks, walls, and paved surfaces. WSSI also uses a drip irrigation system because the majority of the ground cover, a native meadow mix 2-3' in height, is taller than the spray heads.

WSSI's landscaping plan uses mainly hardy, native plants; native plants are accustomed to Virginia's water cycles and do not require extra water to thrive. This helps the site to conserve water year-round.

Native Inkberry Holly and drip lines

Irrigation equipment and cistern vent

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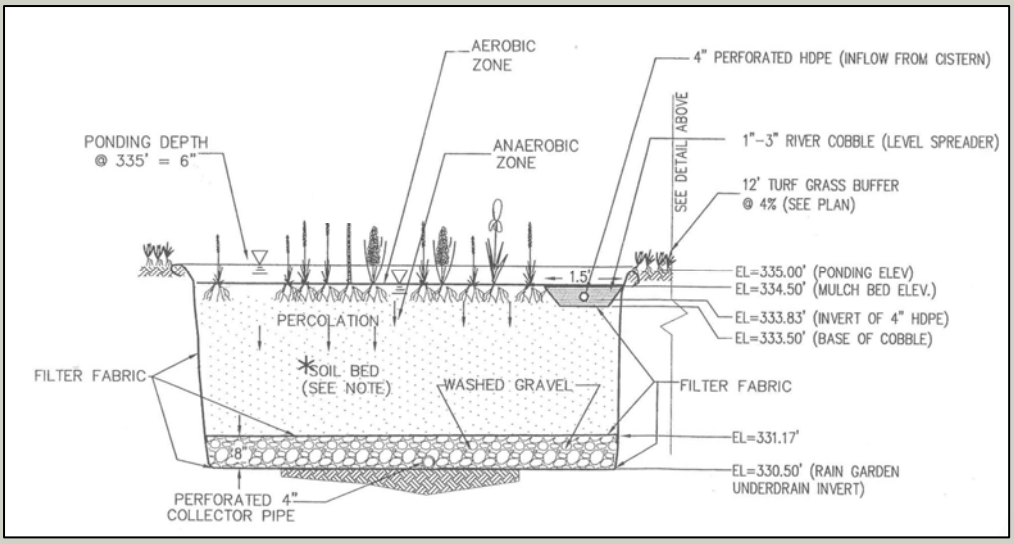
Low Impact Development - *The Rain Garden*



Section View– Rain Garden

The 1,536 square foot rain garden collects water from the roof and the impervious parking surfaces surrounding the building and then filters that water through the soil, mimicking natural hydrologic processes. The rain garden is surrounded by a sod buffer (11,700 square feet) which filters pollutants and debris from the water before it enters the ponding area. Water ponds for short periods after rain events; to avoid creating mosquito-breeding habitat, the water infiltrates within 12 hours.

The rain garden is comprised of two media layers separated by filter fabric. Water first filters through a 3' layer of sandy loam (approximately 83% sand, 8.5% on-site topsoil, and 8.5% leaf mulch). The high sand content gives the media its infiltration capacity, while the organic matter and topsoil help the plants grow. Beneath the soil media, a 1' gravel layer provides storage capacity and encases an underdrain that leads to the gravel bed detention area. The underdrain is necessary because the in-situ soils have high clay content and low infiltration rates; without the underdrain, the rain garden would fill with water and become a wetland.

The native species in the rain garden, including perennials, shrubs, and trees, uptake some of the collected nutrient pollutants through evapotranspiration. Their roots create macro-pores in the soil, which increase the rate of infiltration through the soil media. The rain garden plants withstand both dry conditions and periods of inundation, similar to a floodplain environment. They also provide shade, habitat, and visual amenity.

Rain garden during a storm

Drawdown after the rain ends

Underdrain - June 2005

Sand layer - June 2005

Soil mixing - September 2005

Flood test - October 2005

First growing season, June 2006

Third growing season, July 2008

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Low Impact Development - *Pervious Parking Surfaces*

Mat installation, Sept. 2005

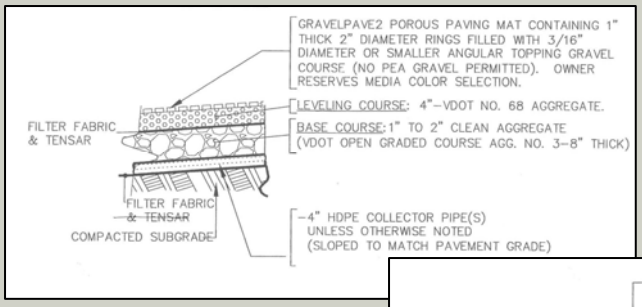
Paver installation, Sept. 2005

Flood testing, October 2005

Concrete installation, May 2008

Concrete installation, May 2008

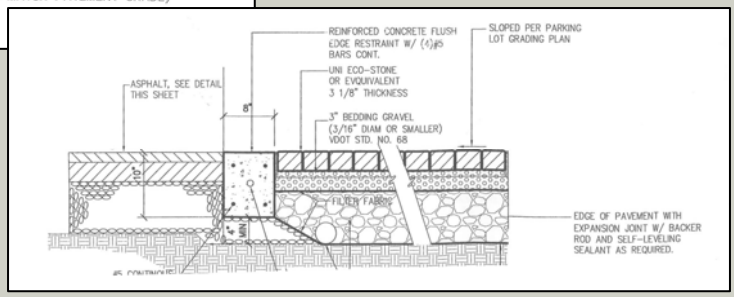
Pervious concrete, 2008



Section View– GravelPave2

The site employs four types of pervious parking:
1) GravelPave2;
2) Non-reinforced gravel;
3) Pervious concrete pavers; and
4) Pervious concrete.

Pervious surfaces allow water to filter into gravel retention layers beneath the driving surface, where it can infiltrate into the ground or be carried to the floodplain by underdrains.



Section View– Pervious Concrete Pavers

1) **GravelPave2** holds gap-graded gravel in a grid of plastic rings fused to filter fabric. The rings keep the gravel from rutting, and the filter fabric separates the gravel from the base layer (see above) to ensure that the permeability doesn't degrade over time.

2) Non-reinforced **gravel pavement** works in much the same way as GravelPave2, except that it uses a single layer of gravel atop a layer of filter fabric, rather than containing the gravel in plastic rings. Gravel pavement was placed in low-use areas, such as ATV trailer parking.

3) **Pervious concrete pavers** are similar to standard concrete paving blocks, except that they are manufactured with spaces at the joints. Water runs into these spaces, which are filled with gap-graded gravel, and is captured in the gravel substrate. The pavers have an extremely high permeability rate, and the gravel substrate allows these areas to accept rain events up to several inches per hour without creating runoff.

4) **Pervious concrete** is similar to standard concrete except that the material contains little or no fine material, leaving void space where water can filter to the base layer.

Because the soils below the site have a high clay content, water can't easily infiltrate to groundwater. Therefore, all pervious parking areas on the site have perforated underdrains beneath them to collect the water and direct it to the gravel bed detention area or existing vegetated floodplains.

Pervious Concrete

Pervious Concrete Pavers

GravelPave2 capturing asphalt runoff

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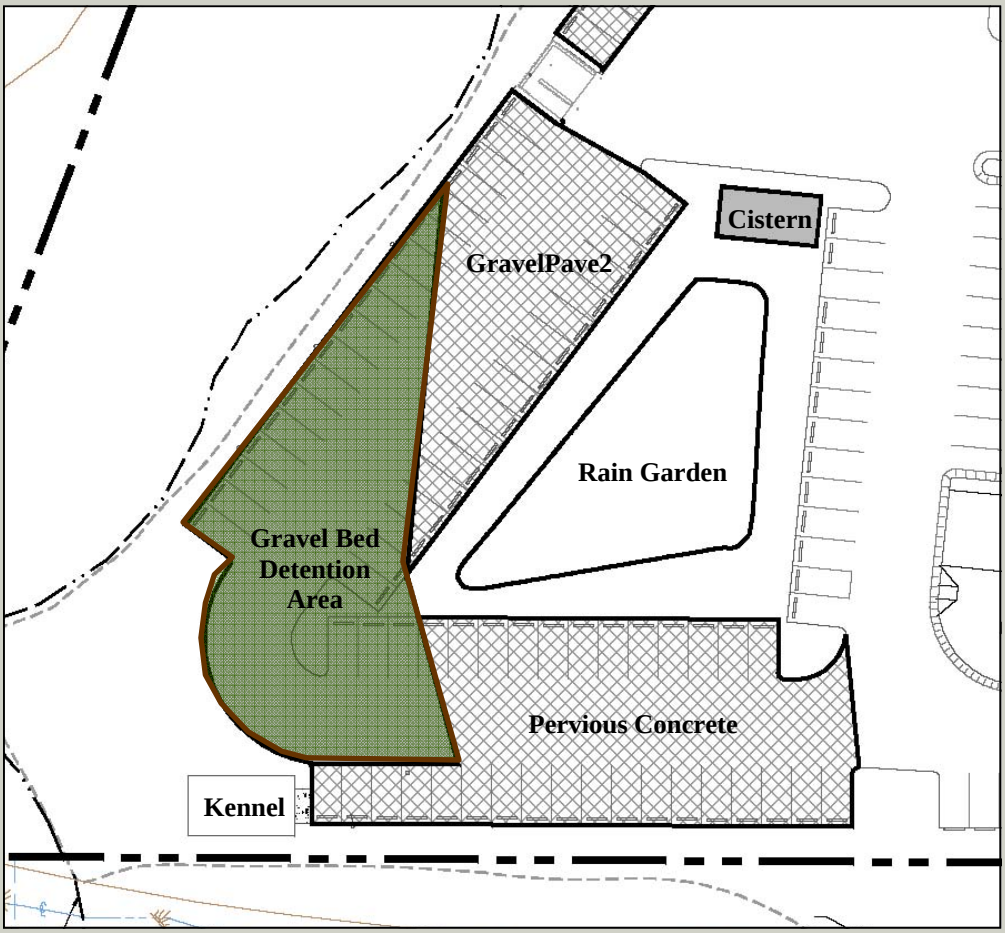
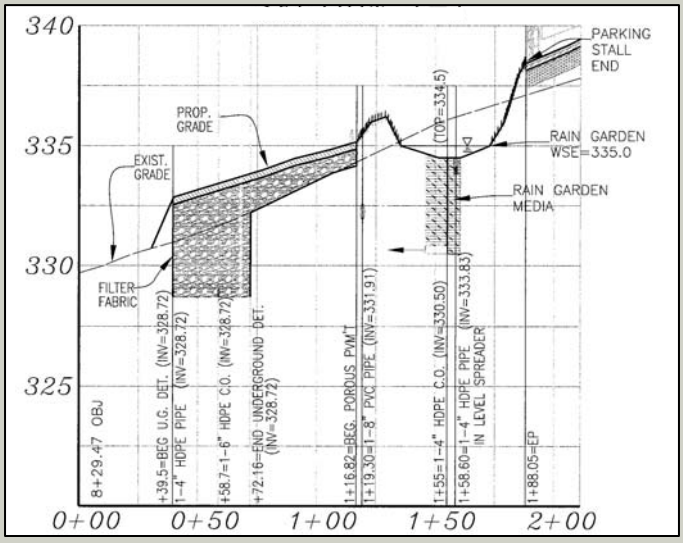
Low Impact Development - *Gravel Bed Detention*



Site Plan Excerpt– Cistern, Rain Garden, and Gravel Bed Detention



Section View– Rain Garden and Gravel Bed Detention

The workhorse of WSSI's site is the gravel bed detention system, which occupies much of the space beneath the rear parking lot (plan view, above.)

The 3.5'-deep gravel bed area (section view, left) collects water from the building roof, rain garden, asphalt parking, gravel parking, and pervious concrete parking. The gravel bed is filled with crushed gravel that has approximately 40% void space. This lets the system to detain 10,500 cubic feet of water. The system slowly releases the water through a 1.625" orifice.

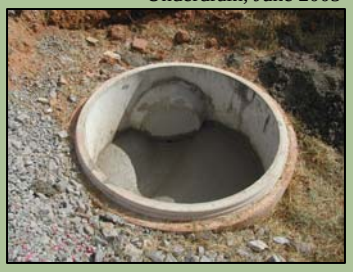
The 1-year storm is released over 24 to 30 hours. After being slowly released from the gravel bed, the water enters an undisturbed wetland and stream system at the back of the site at a low velocity and at an acute angle to the existing flowpath, which helps to minimize streambank erosion.

Outlet manhole, May 2005

Filter fabric, June 2005

Filter fabric, June 2005

Underdrain, June 2005



Outlet Structure, October 2005

Detention Area, October 2005

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Recycled and Regional Materials

The building contains 26% recycled materials- carpets, linoleum, metal doors, steel studs, resin and wheat board panels and partitions, drywall, ceiling tile, ceramic tile, concrete block, and furniture all contain recycled content.

35% of the building's materials were manufactured within 500 miles– the building's concrete blocks came from just across the street! Regional materials are "green" because they require less energy to transport than materials from farther away.

Rapidly-Renewable Materials

The fabric in WSSI's workstations is made from polylactic acid (PLA). PLA is a corn-derived polymer that has properties similar to typical plastic. PLA is rapidly-renewable and is cleaner to produce than traditional plastic.

WSSI's worksurfaces and cabinets are made from wheat board instead of wood. Wheat board is a type of particle board made from resin-bonded, pressed wheat. Unlike standard particleboard, wheat board does not "off-gas," or give off harmful emissions.

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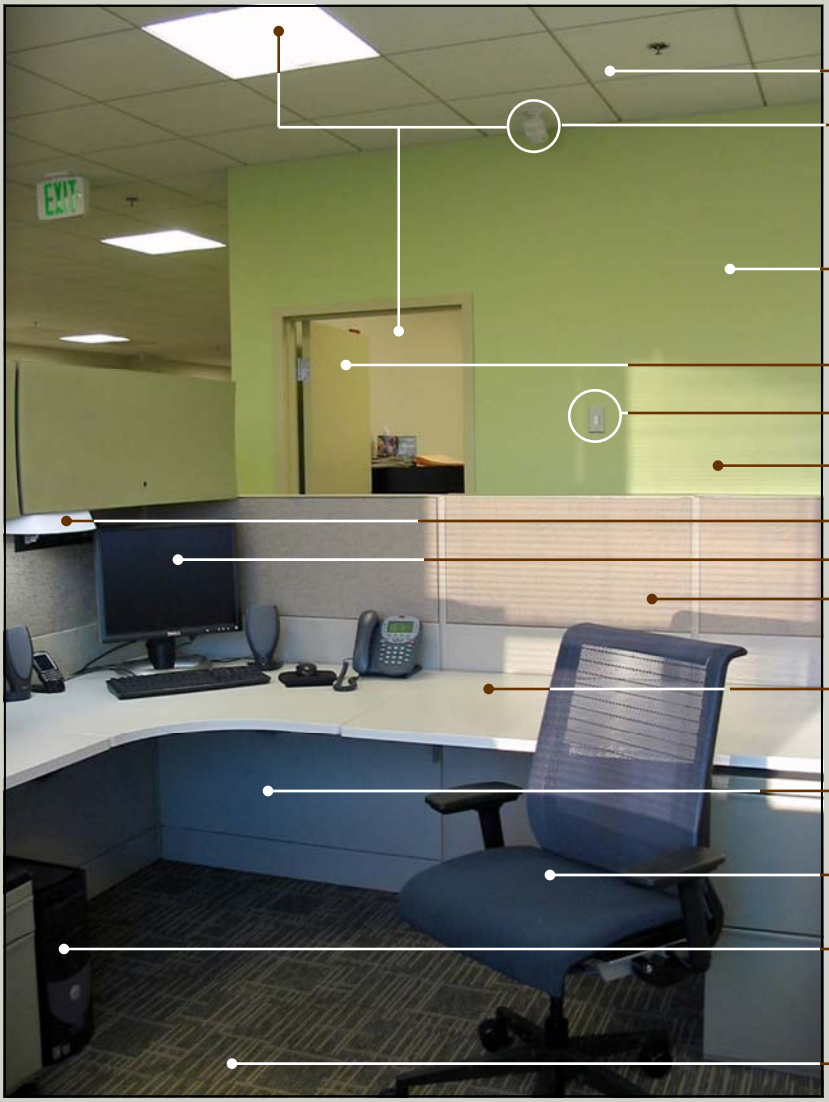
Leadership in Energy and Environmental Design - *The WSSI Interior*

The site's environmentally-advanced design extends to the interior of the building as well. 62 individually-controlled thermal comfort zones, individual task lighting, emission-free fabrics and surfaces, and low-VOC (volatile organic compound) paints and coatings ensure that the building is both comfortable and healthy to work in. The thermal zones and task lighting allow employees to tailor their environment to suit their personal preferences, and the low-emission surfaces and coatings enable them to breathe freely. Both of these considerations lead to a happier, healthier workforce.

The building is also energy efficient. Motion and daylight sensors maintain fluorescent lighting at levels near 0.9 Watt/s.f. (rather than the typical 1.6 Watt/s.f. level). R-30 insulation (rather than the typical R-19) in the roof; R-19 insulation (rather than the typical R-11) in the walls; and windows with a U-value of 0.47 (rather than the typical 0.63) keep the building cool in the summer and warm in the winter. 92% of eligible electronics (such as the kitchen appliances, copiers, computers, monitors, and printers) sport the Energy Star label. These measures provide an estimated 17% reduction in electricity use over ASHRAE standard 90.1-2004, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, and approximately 30-35% energy savings over a typical building of the same size in Northern Virginia, and the building is equipped with continuous sub-meters to monitor energy use. Furthermore, the building's energy needs are 100% offset by the purchase of "green energy credits" that help supply the regional power grid with clean, renewable energy.



Typical WSSI workstation

Leadership in Energy and Environmental Design - *Innovative Spaces*

The building's unique character doesn't stop at the cubicle walls. Green features abound from the kitchen to the restrooms, and everywhere in between.

Water Savings

WSSI's building uses approximately 50% less potable water than a typical building of the same size. Kitchen and restroom faucets are low-flow and sensor-activated. Toilets and showerheads are also low-flow and use 30% less water than typical fixtures. The men's room features waterless urinals to ensure that as little water as possible goes down the drain.

Additionally, WSSI's interior cistern supplies toilet water from roof runoff, reducing the demand for potable water even further.

The Light System

The majority of employee work areas skirt the perimeter of the building, where large windows supply abundant daylight. Within 15' of the windows, photocell daylight sensors override the light controls, turning the lights off when there is sufficient daylight.

The light system also utilizes motion sensors, timers, and energy-efficient, full-spectrum compact fluorescent bulbs. These measures ensure that the lights are energy-efficient and also create a pleasing work environment.

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Employee Health and Happiness

WSSI strives to do the right thing for its employees as well as for the environment.

WSSI offers a detached 6-room kennel to house employees' dogs during the workday.

Inside the building, employees enjoy a gym with cardio- and weight-machines, sports equipment, and trainer-led workouts several times per week.

Employees also have access to company bicycles and a bike trail that leads to the nearby shopping center.

"Caution - Dogs at Play"

WSSI Gym, 2007

WSSI Gym, 2007

Additional Efforts - *Green Retrofits and Upgrades*

Since its employees moved in, WSSI has found many ways to upgrade the office and grounds with additional green features.

Living Walls– GreenScreen® living walls adorn portions of the east and south sides of the building. GreenScreen® is a 3-dimensional lattice that bolts to the side of the building as a habitat for vines. The vines provide shade and cooling for the building (as well as food and habitat for animals) in the summer, while loosing most of their leaves to provide sunlight to the building in the winter.

Interior Cistern– WSSI's interior cistern is a 4,000-gallon plastic tank connected to two of the roof's five downspouts. The cistern captures the equivalent of 0.25" of rain from the roof when completely empty, and the water is used in the building's toilets. On average, the cistern has enough capacity to provide all but three days of water per year. Combined, WSSI's two cisterns capture and reuse approximately 35% of all rainwater that falls on the roof.

Solar Hot Water– WSSI's Apricus® solar water heating system provides hot water for the building's showers and sinks. It is a closed-loop, active system that uses a heat exchanger to heat the water in the interior tank. Even on overcast days, the system provides a substantial amount of heating power.

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Lessons Learned - *WSSI's Thoughts After Certification*

At WSSI's certification date, there were 334 projects certified under the LEED rating systems in the United States. Of these, 96 had been certified Gold or Platinum. Only eight projects in Virginia had been LEED certified, and WSSI's Gold project was the first of those to rise above the Silver level. A searchable list of certified buildings can be found online at the U.S. Green Building Council's website, http://www.usgbc.org.

Although the path to an environmentally-conscious building was long and sometimes frustrating, WSSI enjoyed blazing the trail for other Virginia projects to follow, and we want to share our experience with Low Impact Development, the LEED process, and green building in general. Here are some things we learned along the way:

- Communication and a good team are the keys to creating a great green building. The designers, engineers, builders, contractors, users, and LEED consultants each play an important role in the fabrication and certification of the building, and having each party on board with the goals of the project makes the process run smoothly.

- The LEED certification process requires minimal submittals, but each project is audited after the initial submission. Keeping all of the relevant information neatly organized, and fully documenting each point up front, makes the auditing process stress-free and gives the team a presentable document they can keep at the site for visitors and interested parties.

- Purchasing "green energy" credits to supply the electric grid with renewable, sustainable energy to offset the building's energy use for two years was one of the most economical ways to obtain two LEED points.

- Using low-flow water fixtures and waterless urinals to reduce potable water demands by 50% is another economical way to earn three LEED points; it's also a sound environmental decision that can be applied to both commercial and residential projects.

- Pervious pavers, pervious concrete, and GravelPave2 were approximately equal in cost (between $6.00/s.f. and 7.10/s.f. for each product). Due to durability and maintenance concerns with GravelPave2, pervious pavers or pervious concrete may be better choices for high-end projects.

- The green roof, while a beautiful and functional component of the building, was not cost-effective as a stormwater management measure. To reduce the cost, a more basic system could be used in the place of the intensive/extensive hybrid, but the practice still is not economically viable when evaluated solely on the stormwater benefits it provides.

- Underground gravel bed storage is a very cost-effective method of storing runoff, especially when it is situated beneath a pervious pavement system which allows infiltration to the gravel bed.

- An irrigation cistern, while useful in the summer, remains full throughout the winter and thus only provides water quality and quantity benefits for part of the year. The cistern is more economically viable when interior uses are permitted.

- Proper design, construction, and maintenance are the keys to successfully implementing LID design on a site.

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The WSSI Project Team

User - Wetland Studies and Solutions, Inc.
Project Management - The Peterson Companies
LID Concept Plan - Wetland Studies and Solutions, Inc.
Civil Engineering - Urban Engineering and Associates, Inc.
Interior Design - Bartzen + Ball
Architecture - W.A. Brown & Associates P.C.
Mechanical, Electrical, Plumbing - Potomac Energy Group, Inc.
Building Commissioning - Advanced Building Performance, Inc.
General Contracting - EEReed Construction, LP
Site Work - S.W. Rodgers

Project Location

For driving directions, please visit us on the web: http://www.wetlandstudies.com/WSSI_Directions.pdf

For more information, or to schedule a tour of the WSSI building and grounds, please contact:
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