

Sustainability September: The Green Roof Nature Station



The Green Roof at Duke also has two demonstration rain barrels, which help collect rainwater that can be utilized in gardening and many other outdoor activities.

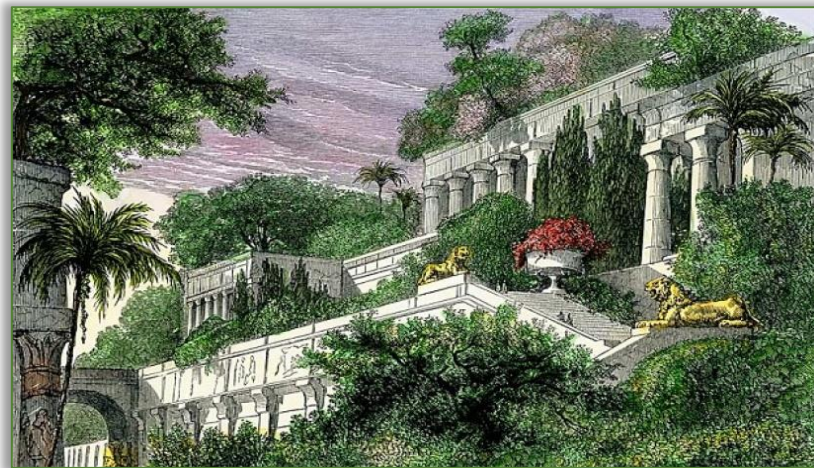
The Green Roof Nature Station at Duke Farms is currently used for “sheltered” outdoor education - a great number of classes for children and adults have been held there, including birdwatching and milkweed community studies. It is also a great place to sit on the benches in the shade just to enjoy the view. Additionally, the Green Roof Nature Station hosts a flat screen monitor that displays Duke Farms updates, as well as photos of featured fauna and flora. There is also a compact bicycle service spot where visitors may attend to their bikes before riding into the Core of the property. But, with its four open-air walls, it’s all about the roof that is intriguing.

Constructed out of materials reclaimed from demolished structures on site, the small building may not look unusual inside, but when you step away and observe the rooflines, you will immediately note plantings, instead of the typical shingles.

When did Green Roofs Begin?

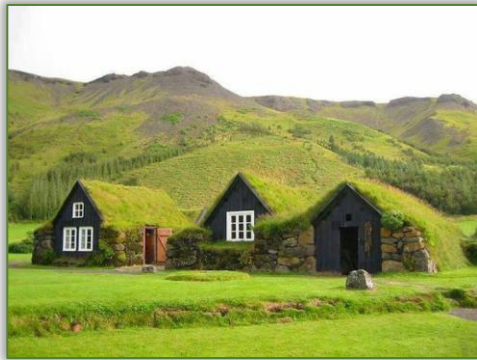
Wonders of the World

Often cited as one of the Seven Wonders of the World, the Hanging Gardens of Babylon are an example of a green roof of sorts. According to the *Ancient History Encyclopedia*, Greek historian Diodorus Siculus, writing in the 1st century BCE, notes that the terraces sloped upwards like an ancient theatre and reached a total height of 20 meters, (65 ft). He describes the terraces as



The Hanging Gardens of Babylon
Image courtesy of [Ancient History Encyclopedia](#)

being built on pillars and lined with reeds and bricks. The theory behind the “why” of these plantings is disputed, but some seem to believe it was for ornamental reasons, while other historians point to the ease of irrigation and the fact that the vegetation was planted in this manner to purposefully cool the structure.

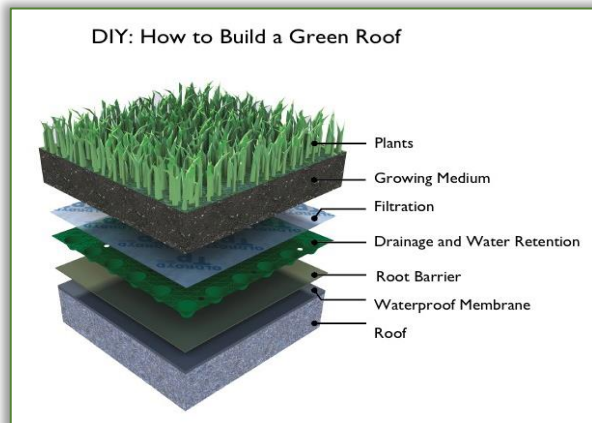


About halfway between Norway and Iceland, northwest of Great Britain, lie the Faroe Islands where it rains mostly every day. Settlers there began using sod on top of their dwellings to protect them from the never-ending rain and to provide thermal insulation.

Modern Green Roofs

The very basic components of most new style Green Roofs include various layers:

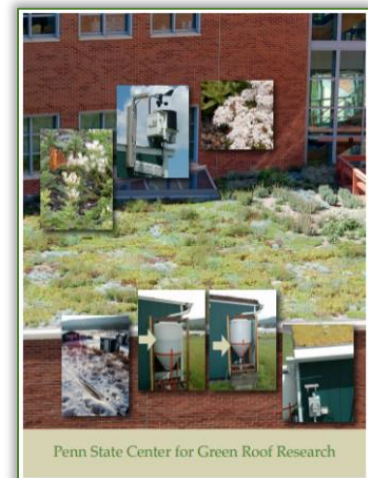
1. **The Waterproof Membrane** protects the roof itself from moisture;
2. **The Drainage Layer** facilitates drainage by directing runoff, so water does not puddle or pool. It also prevents the plant roots from damaging the roof.
3. **The Growing Medium** is carefully selected to provide a secure rooting system and is often a light weight mixed soil composite.
4. **The Plants** must tolerate the conditions of all components of the roof top environment and are selected to be sun loving and be very low maintenance.



The configuration might look like this.

Green Roof Plant Selection

According to the Penn State Center for Green Roof Research, plant selection depends on the design intent for the roof, the climate and microclimate, irrigation, maintenance constraints, and the depth of media. Shallow (less than 5-inch-deep) roofs without irrigation will have a relatively limited choice of plants that can be used, including sedums and a few other very drought-tolerant species. As roof media depth is increased, the roof becomes more garden like and can support a broader range of plant species. Intensive roofs with media depth greater than 1-3 ft can support trees and shrubs as well as herbaceous annuals and perennials. More complicated plantings will increase maintenance and management requirements. Check out [this brochure](#) for more helpful info!



The National Building Museum (Located in Washington, DC and an interesting place to visit both in-person and virtually) provides information about Green Roof and Sedum!

The following plants are mainstays of any green roof and should form the bulk of the planting, unless provisions are made for the roof to support soil deeper than the typical 3- 4 inches. These tiny succulents thrive with virtually no water or soil. They are available in a kaleidoscope of colors, giving a broad palette with which to design your living roof.

- ***Sedum spp.*** Also known as stonecrop, because the succulent foliage resembles smooth, polished stone, sedums are the royalty of living roof plants. There are literally hundreds of varieties, found growing in cliff-side cracks and crannies around the world and were the first species employed in the green roof industry. With so many distinctly colored varieties available, you can paint a beautiful picture on your roof.



Image: Sempergreen

- ***Sempervivum spp.*** Called houseleeks (because they were used as a traditional Scandinavian rooftop plant) by some and **hen and chicks** by others (the mature rosettes “give birth” to tiny replicas of themselves as they spread), *sempervivum* means “evergreen” in Latin, indicating that your roof will be attractive year-round with this type of succulent. Like sedums, they stay low to the ground and come in many colors.



- ***Delosperma spp.*** are spreading succulents grown for their daisy-like flowers, which bloom throughout the growing season. There are white, yellow, red, and purple varieties and most have the habit of changing their shade of color as the flowers fade, creating a monochromatic effect



- ***Aeonium arboreum*** is a variety of houseleek that grows as a tiny tree (usually less than two feet tall) that looks like it would be more at home on Mars than planet Earth. It’s not a spreading ground cover like the other succulents on the list, but it can create a bit of vertical variation in your roof garden. The variety or (black head, in Dutch or German) will create plenty of interest with its color as well—it’s such a deep purple that it’s almost black.

Green Roofs - Diverse Locations with Diverse Design

In 2014, the FBB (Fachvereinigung für Bauwerksbegrünung e.V) a longstanding green roof association, awarded the Allianz Insurance Company (Stuttgart, Germany) the Green Roof of the Year Award. At that time, the green roof was about 30 years old. The insurance company created this design with the intent to lower its environmental footprint and they have even incorporated porous pavements. The building is an indicator that green roofs have staying power and long-term success. Wherever green roofs are located, they not only provide environmental benefits, but an aesthetically interesting landscape. [Follow this link](#) to see some of the many different styles!



Image: [INHABITAT](#)



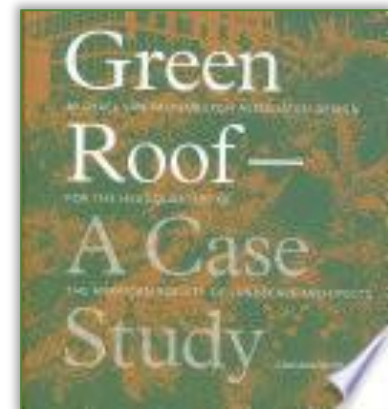
Nanyang Technological University, Singapore



[The Podium Toronto City Hall Green Roof](#)

In the book, *Green Roof - A Case Study* by Christian Werthmann, an

architecture and design theorist, states that green roofs were always very much supported by the German public and spread in significant popularity in the 1970-1980s. German engineers and scientists, in turn, became actively involved in designing the best structures to manage storm water runoff and to reduce flooding on their streets. As a result, lightweight, easy-to-maintain and inexpensive roof top systems now span Germany and over 40 municipalities have laws that either require or encourage green roof construction. In Berlin, large construction projects must now have a green roof component and approximately 14% of all roofs have been “greened.”



Green roofs in the United States have also been popular, particularly in cities where their colors enliven the browns and greys of tall buildings.

New York City might surprise you with how many green roofs help move the city towards a greener future! Check out [this great article from the Nature Conservancy](#) about the initiative.



Public School 41 in Greenwich Village, NYC boasts an expansive green roof!

Bee Stop Bus Stop



Image: [BrightVibes](#)

In the Netherlands, over 300 green roofs are apparent in their fourth largest city of Utrecht. Bus stops have also become bee stops and contribute to the city's biodiversity, supporting insects like honey bees and bumblebees. In the United States, the city of Chicago has many roof top stations and around the country, more and more are popping up with the intent to bolster our dwindling pollinator populations.

Green Roofs on the Road

There have been some creative and interesting ways to mobilize green roof designs. Using lightweight aluminum structures, Lulu's roof garden is built on top of a food truck which features fresh produce and biodegradable packaging. Growing hydroponically in the secured rows of planters are herbs, mustard greens, rosemary, lavender, strawberries, and mint. Employees climb on the roof and harvest from the garden in the morning to supplement the food they make and sell during the day. The developer, Cosio, wanted to provide a fresh alternative to traditional street food in St Louis.



Marc Granen, landscape designer and lung transplant recipient is passionate about air quality and reducing carbon in the atmosphere. His first bus is currently being used to transport tourists to and from a nature and camping facility in Girona, Spain. The roof has been named PhytoKinetic and uses condensation for the air conditioning units to water the plants. His plan is to continue using the hydroponic foam to plant roof top growing on other vehicles.



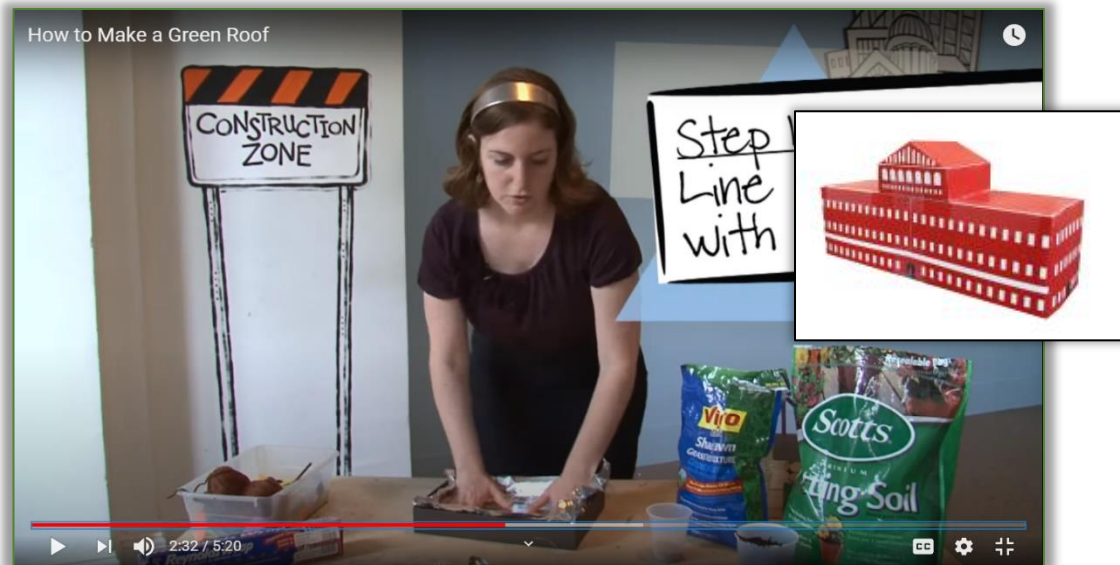
More Awesome Information and Activities



[Barn Outpost Green Roof Demonstration](#) was constructed with materials reclaimed from demolished structures on-site. Plantings on the rooftop help to reduce heat build-up in the warmer summer months.



Green roofs are a great way to help the environment and improve your community. Elementary school aged students are learning to build their own green roofs [thanks to a partnership between the University of Nebraska-Lincoln College of Architecture and Nebraska Extension.](#)



[In this fun, educational tutorial](#) you can learn how to make your very own green roof out of materials that you have at home. Guaranteed fun for the entire family.

Interested in building your own model of the National Building Museum? Check out this awesome activity!

Cool & Collected

AROUND THE
WORLD IN 80
PAPER MODELS

MINI NATIONAL BUILDING MUSEUM

The historic home of the National Building Museum is one of the great American buildings of the nineteenth century and one of Washington, D.C.'s most spectacular works of public architecture. Built between 1882 and 1887, it was originally intended as a suitable, fireproof building for the U.S. Pension Bureau's headquarters. U.S. Army Quartermaster General Montgomery C. Meigs was appointed as both the architect and engineer for the building. Almost a century later in 1980, it was designated by Congress as the home of the new National Building Museum.

Green Roof Book and a Grow Your Own Green Roof

If you are looking for a book and an activity, try partnering There's A Sponge Growing On My Roof with an activity to create your own "sponge house" where seeds can easily sprout!



Source: Pinterest



Climate Change

The topic of Green Roofs can span the curriculum where you can include, math, science, technology, architecture, geography, biology and much more. Importantly, for these reasons, it is directly aligned with Climate Change Curriculum. For more information about how you may use this lesson in your classrooms, contact Kate Reilly, Manager of Education, Duke Farms kreilly@dukefarms.org

Adopted 2020 New Jersey Student Learning Standards (NJSLS): Climate Change

New Jersey is the first state in the country to require climate change curriculum across all content areas and at a K-12 level. As stated by the NJDOE: On June 3, 2020, the State Board of Education adopted the 2020 NJSLS in the following content areas:

- Career Readiness, Life Literacies, and Key Skills;
- Comprehensive Health and Physical Education;
- Computer Science & Design Thinking;
- Science;
- Social Studies;
- Visual and Performing Arts;
- World Languages.

These standards truly represent a foundation from which districts will build coherent curriculum and instruction that prepares each New Jersey student with the knowledge and skills to succeed in our rapidly changing world. They will put New Jersey again at the forefront of national education by including "climate change across all content areas, leveraging the passion students have shown for this critical issue and providing them opportunities to develop a deep understanding of the science behind the changes and to explore the solutions our world desperately needs."