Innovative Rainwater Management and Green Design

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Celebration of Raindrops:
An Innovative, Interactive Approach to Rainwater Management

University of Illinois at Urbana-Champaign
Student Team D15

Abstract

Located at the south-western area of University of Illinois at Urbana-Champaign, the site is part of the UIUC Research Park. Despite its noticeable location near the State Farm Center arena and the iHotel (the university's official hotel), the area remains an unappealing space because of lack of canopy shade and plant diversity as well as an discontinuous pathway. The runoff from unutilized fields and impervious parking lots is discharged directly to the existing retention pond that is connected to the Embarras River, a waterway beginning in Urbana-Champaign. This runoff has high concentrations of phosphorus, nitrogen, and suspended solids, and eventually leads to the Gulf of Mexico where these contaminants harm its rich ecosystem and create a large deadzone where dissolved oxygen is minimal. "Celebration of Raindrops: An Innovative, Interactive Approach to Rainwater Management" is designed to remedy those problems and to provide a space where students, staff and visitors all can enjoy the interaction with nature and learn more about green infrastructure. The design proposal consists of a constructed wetland, several retention/recreation ponds, a rain garden, experimental farmland, and the transformation of an abandoned silo into a water center. Tying these features together are a rainwater treatment and purification system, a clean water recycling and redistribution system, as well as a greenway system. Furthermore, our project can assist in achieving the University's Illinois Climate Action Plan (iCAP) goal of achieving long-term carbon neutrality by providing an infill design example at underutilized open space.

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Project Context

The site is part of the UIUC Research Park, which is positioned for continuous expansion on campus.The growth reinforces the need for a demonstration project that addresses the critical issues of: land use, circulation, infrastructure, parks and recreation. We chose the underutilized area in the north-east block of the research park as our site, to create a distinct identity and to enhance a sense of place for the Research Park and to reinforce its connection with the campus core.

The study area is 50 acres including the surrounding buildings and parking lots while the site of the project is 15 acres. In the north of our site, there is State Farm Center, the third largest Illinois arena, which holds games and conferences every season. The iHotel and conference center are located in the west of the site, providing services for every Illinois game day, alumni reunion, wedding, celebration, community event, or staff meeting. The other buildings inside the study area are office buildings and research labs. A large greenhouse on the east of Fourth Street is operated by a crop research lab across the street.

In terms of topography, our site is situated on a ridge line that divides the whole campus into two watersheds. The rainwater runoff of the study area will be drained to the East Branch of the Embarras River floodplain to the South. The flow of nitrogen and phosphorus from nearby farms and untreated wastewater into the Embarras River, part of the greater Mississippi River watershed, contributes to the growing hypoxic zone in the Gulf of Mexico.

Site Analysis

A number of problems and some advantages are presented based on several site visits and interviews with local users. The large area of impermeable paving for parking lots and the lack of tree canopy in the study area creates heat island effects that make the site measurably warmer than surrounding areas on summer days. Combined with soil types that have a high runoff potential, there are serious environmental factors to consider.

The majority of the site, adjacent to beautiful farmland to the east, is not accessible to bikers and pedestrians. The existing retention pond is a great place for relaxation and recreation, according to Benjamin, a manager who works in the crop research lab, however, there are no few amenities to enjoy there. The pathway around the retention pond is not connected or continuous. Furthermore, it is difficult for Benjamin to check on the greenhouse to the east of Fourth Street after working in the research lab across the street because there is no

pedestrian crossing. The Research Park is bisected by Fourth Street, which has led to inefficient and dangerous pedestrian circulation.

In addition, the rainwater on our site is discharged directly to the existing retention ponds, which smell bad on rainy days, especially due to the service vehicles of the iHotel and the abandoned silo to the north. The majority of the rainwater management system is closed and buried so that visitors have little knowledge or awareness about the process and green infrastructure.

Local Acts and Plans

Several current local regulation acts and action plans apply to the site. The City of Champaign requires all new development and redevelopment to provide for rainwater detention on site and drainage designs that minimize impervious surfaces, attenuate flows via open vegetated swales, and preserve natural waterways.

The Illinois Nutrient Loss Reduction Strategy, developed by the Illinois Environmental Protection Agency, Illinois Department of Agriculture, and University of Illinois Extension proposes and helps implement measures to improve water quality in the region and downstream by reducing nitrogen and phosphorus levels in runoff, promoting sustainable agricultural practices such as cover crops and reduced fertilizer application, and the installation of green infrastructure features like green roofs and green urban rainwater practices like street sweeping and leaf collection.

The University has approved two landmark plans that affect our design: the Illinois Climate Action Plan (iCAP) and the Resilient Landscape Strategy. iCAP sets sweeping sustainability goals for the entire campus, including becoming carbon neutral by 2050.

Furthermore, it sets several nearterm land and water management goals, including: reducing the campus's use of potable water by 40% by 2030; doubling pollinator-friendly spaces by 2024; and, doubling green infrastrastructure installations by 2024.

The Facilities & Services department approved its Resilient Landscapes Strategies in 2018, which aims to make the campus an exemplar of resilient rainwater management. It recommends the addition of bioinfiltration cells with native plantings and bioswales for parking lots and roadways; increasing tree planting; and, rainwater harvesting. It also places emphasis on community education surrounding rainwater management to increase awareness and participation in campus stewardship.

The current master plan for the Research Park recommends infill development and that new development be clustered around rainwater management facilities and be right-sized to discourage excessive parking, reducing impervious surfaces and the heat island effect.

Project Goals

The goal of this project is to provide a dynamic, sustainable, and innovative space for the local community, to set an example for future infill development on campus, and to advocate for sustainability and green infrastructure worldwide. We identified six design objectives to address social, environmental, and economic concerns:

1. Reduce rainwater runoff and prevent flooding
2. Improve water quality of the Embarras River
3. Reduce potable water consumption
4. Improve plant diversity and enhance the broader ecosystem
5. Increase accessibility to green space
6. Educate students, staff, and visitors about sustainability and green infrastructure
7. Provide an aesthetic, accessible, and continuous space for relaxation and recreation

Design Solutions

The design is composed of six zones to provide a dynamic experience on the site: Terraced Wetlands, Central Lake, Hook Pond, Mediation Garden, Education Farmland and an Aquatic Tower. Several green infrastructures have been implemented in the six zones to create an innovative, interactive approach for rainwater management. To achieve the design objectives, we propose four strategies:

1. Greywater Treatment and Purification System

The greywater treatment and purification system makes use of the existing topography of the site and purifies the rainwater collected from surrounding building roofs and parking lots by plants in a multi-step system consisting of a constructed wetland, several retention and recreation ponds, and a rain garden.

1.1 Terraced Wetlands

Located in the northern section of the site, Terraced Wetland is a constructed wetland that uses natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality. The site topography gradually decreases from north to south, with three small curved pools of water distributed along the main roadway of the site. Rainwater is collected in this pool and then flows downward with the topography. The rainwater is purified by layers of wetland plants between the steps by the wetland plants, flows into a circular strip pond in the middle of the wetland, which then converges into an oval-shaped pond.

On the north side of the circular pond, three large, curved steps are set up, which are hidden among the wetland plants. In the center of the circular band pond is a stage on which people can perform or conduct group activities. To the south of the oval-shaped pool, shorter curved steps are set up on which visitors can sit and view the landscape. The pond and wetland plants, the stage in the middle of the site, and the water tower form a richly layered picture for visitors. At the southeast corner of the constructed wetland is a landscape bridge that connects the constructed wetland to the Vegetated Bioswale, giving the entire site a sense of unity. At the same time, the bridge adds to the visitor experience.

1.2 Central Lake

Central Lake redesigns the edges of the existing retention pond on site to connect with Terraced Wetlands and Hook Pond. Two weirs slow the flow from Terraced Wetlands before entering Central Lake. An open, vegetated bioswale extends from the large parking lot of the iHotel's conference center allowing runoff to flow into the main basin between the weirs, trapping sediment, suspended particles, and debris.
West of these weirs a tallgrass prairie buffer strip provides similar functions for parking lot runoff not channelled into the bioswale.

Surrounding Central Lake is a loop pathway which connects to the broader greenway system, with two bridges crossing the streams that connect it to Terraced Wetlands to the north and Hook Pond to the south. The path widens south of the tallgrass prairie strip to form a plaza with two large planters with trees fitted with seat walls facing the water. Between the path and the water's edge is densely planted wetlands, cleaning the water and creating vital aquatic habitat. Together the plantings in this section of the design are evocative of the two dominant ecosystems in the region: wetland and prairie.

Just off the path on all sides of Central Lake are three sunken, outdoor classrooms, which can be used for educational events, social functions or casual enjoyment. The floor of each classroom is two feet below grade, creating enough depth for a built-in seat hugging the perimeter, inviting visitors to view their surroundings from a new perspective, closer to the earth and water. Their shape is reminiscent of the organic flow of water drops, echoing the central theme of the design.

1.3 Hook Pond

Hook Pond functions as both a recreation pond and part of the larger rainwater reuse system. After a series of rainwater treatments, clean water resources will be collected in the recreation pond and transformed into the water features. The water feature in this area includes a small crescent-shaped pool and a large pea-shaped pool.
The recreational pool area has three main activity spaces: a wetland park, terraced seating and a fishing platform. The wetland park is mainly for leisure walks and wetland plants exploration. Terraced seating creates a relaxing space to enjoy the tranquility of the surroundings. The stocked pool is located on the south side of this section where visitors can bring their own tools or rent here to enjoy the fun of fishing.
As part of the rainwater management system, the recreation pond has plans for different water levels in this area, marked by two edges. Between these two edges is a square marked with pebbles. When the water level is low, the square will be exposed. People can touch the treated water in the square and feel the effects of water treatment while having fun. When the water volume is large, this square will be submerged and become a part of the pool, increasing the pool's capacity. Visitors can reach the lakeside square through the trail surrounded by plants and rest on the seats beside the flower beds. After large storm events when the water volume exceeds the capacity of the ponds, it will be discharged into the pond of Education Farmland across Fourth Street to the east.

Purchase this course to see the remainder of the technical materials.