Kroon Hall, Yale School of Forestry & Environmental Studies – New Haven, CT
Methodology for Landscape Performance Benefits

Environmental

- ***Saves 634,000 gallons of potable water each year by eliminating the need to use potable water for irrigation and, in concert with water-conserving plumbing fixtures, reducing the building's potable water use by 81%.***

Saves 634,000 gallons of potable water…

To optimize the design of the rainwater harvesting system, the Team conducted a rainwater harvesting simulation using Nitsch Engineering's proprietary RainUse™ software that was initially developed by the firm for use at Yale. RainUSE uses daily rainfall records available from the Northeast Regional Climate Center at Cornell University for a specified time period and a specific National Weather Service station. Based on the hydrologic characteristics of the catchment area, RainUSE determines the rainwater supply available for reuse on a daily basis. Then, RainUSE simulates the routing of the rainwater supply through various tank size configurations to meet the user-input daily demands. Throughout this simulation, RainUSE tracks the "reliability", or efficiency, of the rainwater re-use system. For each tank size configuration, RainUSE provides the designer with the reliability, or percentage of time rainwater will be available to meet the demand. The RainUSE software can also account for additional make-up water supply inputs.

As shown in the following table, the RainUSE simulations were run for rainwater harvesting with and without the groundwater make-up source. The column on the right represents the system that was constructed, with the supplemental groundwater make-up source, which is anticipated to meet 98-100% of the monthly demand for toilet flushing and irrigation. The groundwater make-up source is water collected and pumped from the building foundation drainage system. This water would otherwise be discharged to the combined sewer system, but a flip valve sends make-up water to the rainwater harvesting tank when its water level is low. Use of this consistent source of make-up water improved system reliability by nearly 50%, a credit to the OLIN/Nitsch Engineering collaboration that "blurred the lines" between each discipline's traditional responsibilities.

Rainwater Harvesting Simulation
Summary of Results

		DEMAND				SUPPLY (Water Savings)			
						Rainwater Only		Rainwater + Makeup Water	
Days	Months	Daily Toilet Flushing Demand (gpd)	Daily Irrigation Demand (gpd)	Total Daily Demand (gpd)	Monthly Demand (gpd)	Projected Rainwater Supply (gallons)	20k Tank Efficiency (%)	Projected Rainwater (& Makeup Water) Supply (gallons)	20k Tank Efficiency (%)
31	January	1,050	0	1,050	32,550	28,539	88%	31,937	98%
28	February	1,050	0	1,050	29,400	28,457	97%	29,400	100%
31	March	1,050	0	1,050	32,550	30,658	94%	31,937	98%
30	April	1,050	832	1,882	56,460	37,232	66%	56,460	100%
31	May	1,050	1,289	2,339	72,509	38,489	53%	71,124	98%
30	June	1,050	1,547	2,597	77,910	33,657	43%	76,301	98%
31	July	1,050	1,633	2,683	83,173	40,508	49%	79,856	96%
31	August	1,050	1,461	2,511	77,841	40,603	52%	75,509	97%
30	September	1,050	1,117	2,167	65,010	37,093	57%	65,010	100%
31	October	1,050	687	1,737	53,847	37,379	69%	52,834	98%
30	November	1,050	0	1,050	31,500	29,664	94%	31,500	100%
31	December	1,050	0	1,050	32,550	29,551	91%	31,937	98%
	Annual				645,300	411,830		633,805	

Annual Total Estimated Potable Water Demand (Toilet Flushing + Irrigation): 645,300 gallons
Annual Projected Water Savings: 411,830 gallons to 633,805 gallons

…by eliminating the need to use potable water for irrigation…

The irrigation system is designed with no backup connection to the potable water system. The irrigation demand was minimized through the use of native plantings. Lawn areas that do require irrigation are supplied only from stored rainwater. The Team performed a simulation analysis to demonstrate that the anticipated irrigation demand could be met with water stored in the rainwater harvesting tank from precipitation and diverted foundation drainage.

…reducing the building's potable water use by 81%.

The total water savings of 81% was calculated by environmental design consultant Atelier Ten in April 2006 for LEED-NC 2.2 WE Credit 3: Water Use Reduction. The summary table from the LEED submittal is shown below:

WATER USE SUMMARY

Baseline Case - Annual Water Consumption (gal):	375,763	gallons/year
Design Case - Annual Water Consumption (gal):	246,236	gallons/year
Total Annual Non-Potable Water Consumption (gal):	175,966	gallons/year
Total Water Savings:	81.3	%

- ***Treats and retains the first 1" of rainfall***
- ***Treats water to remove 80% of total suspended solids (TSS) for all water discharged to the municipal stormwater system.***

The majority of stormwater runoff from the northern portion of the site and building roof is collected in a closed drainage system and directed through a 6-foot diameter manhole with a 4-foot sediment sump. The "first flush" (1-inch) of runoff is directed to a water feature with floating plants to act as a biofilter and provide natural water quality polishing. The water feature has an overflow to a 20,000 gallon rainwater harvesting tank to be reused inside the building and for

The stormwater runoff from the southern portion of the building roof and site are collected in a closed drainage system and directed to a 10,000 gallon detention tank. The overflow from the tank, as well as remaining site drainage areas, is directed through a water quality unit (Vortechnics) before being discharged from the site.

A summary of the treatment BMPs for each subcatchment area are calculated below. Refer to "LEED SSc6.2 Drainage Diagram" for delineation of catchment areas within the LEED® Project Boundary.

Subcatchment	BMPs	TSS Removal Rate	Area of Subcatchment (AC)	% of Site Area
Northern Site	Biofilter	80%	0.798	27%
	Rainwater Harvesting	-		
	Vortechnics	80%		
Southern Roof	Vortechnics	80%	0.872	29%
Southern Site	Vortechnics	80%	1.295	44%
Project Total				100%

The following BMPs were used on this project:

Biofilter/Water feature

- Description of BMPs Contribution to Stormwater Filtration: The water feature is sized to treat the "first flush" (1-inch) of stormwater runoff from its contributing area. The stormwater runoff directed to the water feature will first pass through a drain manhole with a 4-foot sump to remove any coarse particles in the runoff. The water feature will have floating aquatic plants which will naturally remove pollutants from stormwater runoff acting as a biofilter. This biofilter will provide a TSS Removal Rate of 80%.
- % of Annual Rainfall Volume Treated by BMP = 0.798 AC / 2.965 AC = 27%

Water Quality Unit – Vortechnics

- Description of BMPs Contribution to Stormwater Filtration: The Vortechnics units are sized to treat small storm events and effectively remove finer sediment, oil and grease, and floating and sinking debris from urban runoff. Water enters the swirl chamber at a tangent, inducing a gentle swirling flow pattern and enhancing gravitational separation. Sinking pollutants stay in the swirl chamber while floating pollutants are stopped at the baffle wall. During larger storms, the water level rises above the low flow control and begins to flow through the high flow control. The layer of floating pollutants is elevated above the influent pipe, preventing re-entrainment. Swirling action increases in relation to the storm intensity, which helps prevent re-suspension. This unit will provide a TSS Removal Rate of 80%.
- % of Annual Rainfall Volume Treated by BMP = 100%

Social

- ***Transformed the site of a decommissioned power plant, parking lot, and patchwork of service roads into a highly visible center for the study of environment on Yale's Science Hill campus. Graduation, happy hour, alumni events, and other school activities are commonly scheduled for the courtyard.***

Both formal and informal university events are commonly held in the new courtyard, including the diploma ceremony for the School of Forestry and Environmental Studies. Over 550 students, faculty and staff occupy Kroon Hall and its grounds each week.