Remediate and Renew

A campus resource for water, food, and engagement

Team Registration D30

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UNIVERSITY OF ARKANSAS | Fay Jones School of Architecture + Design

Abstract
Stephen L. Anderson Design Center and Vol Walker Hall house the Fay Jones School of Architecture and Design at the University of Arkansas. While an AIA award-winning building, it is clear that the site lacks measurable environmental benefits. With multiple underutilized areas on the green roof, as well as an undeveloped surrounding landscape, two solutions naturally arise: stormwater mitigation systems and food production and distribution opportunities. Team Renew proposes a design project that reduces stormwater runoff and provides ways to feed the community, campus, and city. Team Renew focuses on three localized projects within the site at-large: the west green roof, the east green roof, and the south lawn. The plan includes permeable pavers, native plantings, catchment areas, occupiable planters, and a food forest. Educational opportunities through signage and site activities are provided so that the user can become more empathetic to the everyday systems that go on around them. In order to ensure that this project is designed correctly as well as implemented in the future, Team Renew worked not only with other colleges on campus, but also with the City of Fayetteville, the campus food bank, and multiple professionals and experts within the Northwest Arkansas area. In order to create a more sustainable site that mitigates stormwater runoff and feeds the public, the university and the community must work together.

Introduction
Team Renew engages two opportunities that arise on this site: stormwater mitigation and food insecurity. On average, the University of Arkansas receives close to 49 inches of rainfall every year, with very few places on our site able to intercept any of that water. All of the surrounding paving is impervious and the plants that currently reside on the green roof are not maintained and are either dead or in a very bad condition. Additionally, the south lawn is all turf, providing virtually no opportunities for stormwater infiltration. The majority of this runoff is directed into out-of-site drainage systems, with its eventual destination being Beaver Lake north of here.

In Northwest Arkansas alone, there are an estimated 2,951 homeless persons, with 56% of those people being under the age of 18. To further expound upon this, Arkansas ranks 50th in the country in terms of food insecurity, with 14% of Washington County being food insecure. College students as well are even more at risk due to generally small budgets and high expenses.

Our design's three primary objectives are to (1) reduce stormwater runoff through mitigation efforts such as green roofs, rainwater collection, and infiltration, (2) provide opportunities for food production and distribution by designing a food forest on the south lawn and raised beds within the new green roof, and (3) alleviate urban heat island effect by introducing more extensive vegetation on the roof. Additionally, this green infrastructure will serve to educate and inform the public about environmental and social issues through both signage and interaction as well as provide opportunity for community outreach. The implementation of this project on campus is expected to both reduce food insecurity in the surrounding community and minimize stormwater runoff on the two buildings that house the Fay Jones School of Architecture and Design.

Local and Regional Context

The University of Arkansas, and Fayetteville as a whole, reside in a level II ecoregion known as the "Ozark, Ouachita-Appalachian forests". A unique region in central North America, it is a place that is not only highly diverse in regards to wildlife, but also home to many old-growth forests. With peaks as high as 2,500 feet, this mountainous region is especially vulnerable to erosion. Excessive stormwater runoff, amplified by above average rainfall and the rapid metropolitan growth, with the usual impervious cover as a result, serves to exasperate this issue.

As the metropolitan area grows, so will impervious surfaces. Between 2010 and 2017, the US Census reported that the Northwest Arkansas region grew at a rate of 16%, ranking as 15th fastest in the United States. With projections showing a 2045 population of almost 1,00,000 residents — double the current population — stormwater remediation efforts are essential now. Runoff will only increase as growth and development continues, further eroding hillsides and polluting sources of water

Furthermore, Northwest Arkansas gets all of their drinking water from Beaver Lake, which supplies over 20 municipalities and more than 350,000 residents in the outlying area. Erosion of the surrounding hillsides from stormwater runoff increases sedimentation in this reservoir, leading to potentially costly fixes down the road. The university itself resides on one of the highest points in Fayetteville, which is bisected by two watersheds: the Beaver Lake Watershed and the Illinois River Watershed. In even minor stormwater events, this can lead to flooded areas and high velocity surface flows, which contribute to the above issues.

Figure 1: an image of Fayetteville during an intense storm event . Flooding is common.

However, there are also social issues at play within the local context. Washington County, where Fayetteville is located, has approximately 15% of its population in poverty, compared to the national average of 11%. A 2016 report conducted by the University of Arkansas found that as many as 42% of students experience either low or very low food security. In addition, minorities such as African Americans, Hispanics, and Asians are 6% more likely to be food insecure than white students. 21% of students surveyed reported that they do not have enough money to buy everyday necessities such as food.

While there is a food pantry that resides on campus, only half of students know it exists, and only 2% reported having used it, perhaps due to its obscure and hard-to-find location.

Site Analysis

The site at-large, which is encompassed within the red dashing in figure 2, is approximately three acres. The Fay Jones School of Architecture and Design, a largely impervious site, takes up about 0.6 acres or 25,557 square feet of the total area. As further explained under the “Design Proposal” section, we propose re-designing three areas in particular within those three acres. A critical part, and arguably the main part, of our site analysis is the examination of water runoff. To define this data, we found it best to collaborate with biological engineering students at the University of Arkansas, who provided us with critical information.

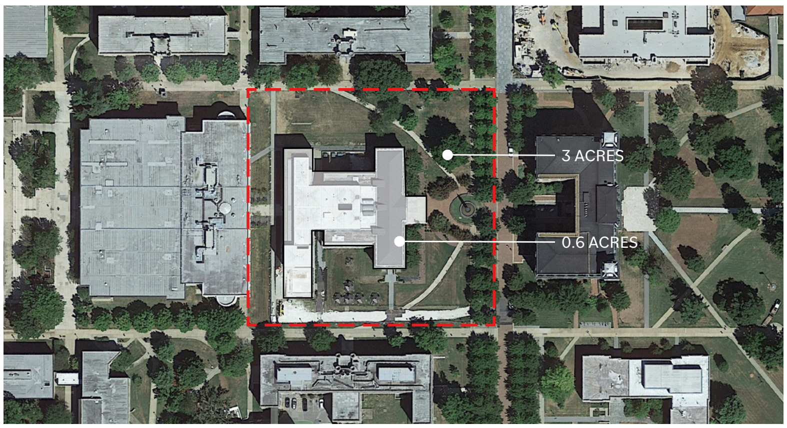


Figure 2: an image of the site with corresponding area. The site at-large is delineated by the red dashed line, while the site specifically is represented by the white overlay.

Our first step was to find the runoff with current site conditions. After delineating the watershed using contour data from the City of Fayetteville, our outlet point was identified. We then created a hyetograph for the 2-year 24 hr storm event in Fayetteville, AR using the SCS curve number method to use as the design storm in our models. CN values were obtained and matched to corresponding areas within the drainage area surrounding the architecture building.

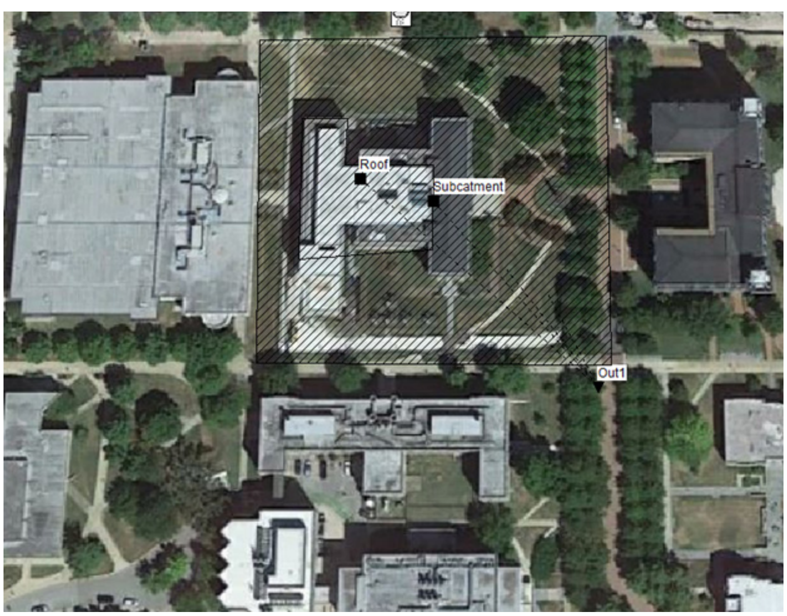


Figure 3: an image of the site with the roof, subcatchment, and outlet point are defined. The site’s watershed is delineated by the black hatching overlay.

The next step was to model the drainage area in SWMM. This was done first for the existing conditions using data from the City of Fayetteville collected previously. Any existing green infrastructure features were also modeled, which includes the green roof on the west end of the building at present. In order to model this green roof, a soil sample was taken from the roof and was tested in the lab to obtain valuable information such as porosity and field capacity. This data was used in the SWMM model, and the final runoff values for existing conditions were obtained as shown below:

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Subcatment	3.89	0.00	0.00	0.94	0.50	2.36	2.87	0.19	2.19	0.738
Roof	3.88	0.00	0.00	0.00	3.73	0.07	3.85	0.06	0.57	0.991

Figure 4: a table showing existing conditions.

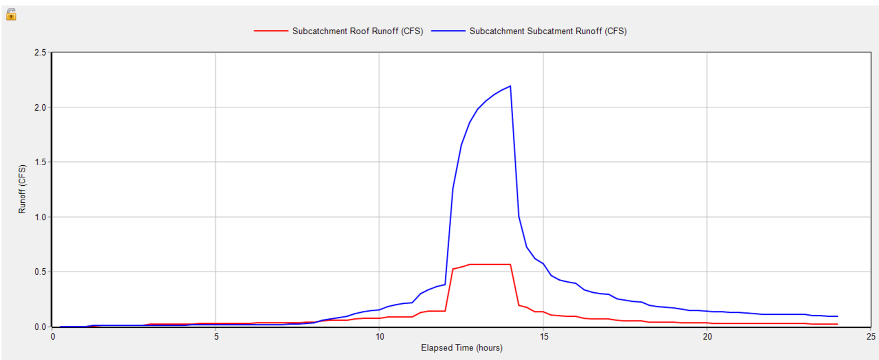


Figure 5: a graph showing existing conditions.

Based on current conditions given a 2-year 24 hr storm event, current total runoff equates to approximately 6.72 inches. Regarding the subcatchment, peak runoff was 2.19 cubic feet per second (cfs). Lastly, on the roof, peak runoff was approximately 0.57 cubic feet per second (cfs). This data, in relation to our proposed design and the overall co-benefits, will be expounded upon in the “Design Benefits” section.

Design Proposal

The design proposal is split into three different areas: the east green roof, the west green roof, and the south lawn. Each of these designs contribute to the proposal as a whole, and work towards accomplishing our earlier-stated goals: (1) to reduce stormwater runoff through mitigation efforts such as green roofs, rainwater collection, and infiltration, and (2) to provide opportunities for food production and distribution by designing a food forest on the south lawn and raised beds within the new green roofs.

The east green roof itself is technically subdivided into two roofs: north and south. New green spaces and stormwater catchment basins will help to reduce runoff and increase infiltration. This captured stormwater will then be used to irrigate the new plantings as well as the raised beds that will be installed. These raised beds will serve to produce and distribute food in conjunction with the proposed design for the south lawn. Study and social spaces are provided as well, along with an enhanced visual connection between the Oculus Room and the surrounding exterior. This will help to foster investigation and, eventually, education.

The design for the west green roof is a further development and refinement of a proposal from 2019. New areas for seating are provided, along with enhanced lighting and a new planting scheme altogether. Small trees will be planted not only to provide shade for the inhabitants, but also to allow for stormwater infiltration along with the newly planted sedums. Opportunities for rainwater catchment will be installed as well, with the collected water maintaining a constant feedback loop of “capture, irrigate, infiltrate”.

Lastly the south lawn will be re-designed into a functional, garden-esque landscape that serves a variety of purposes. A proposed plaza outfitted with permeable pavers and native trees will serve the many malleable needs of a design school: a study space, a classroom, an opportunity for relaxation or fabrication, or an exhibition space. A food forest on site will aide in the production and distribution of food to food insecure students on campus, and on a much larger scale than the east green roof. Stormwater collection containers are designed elements that will capture any water that falls on the Vol Walker Hall roof. This water will then be used to irrigate the accompanying food forest and newly-planted trees and vegetation.

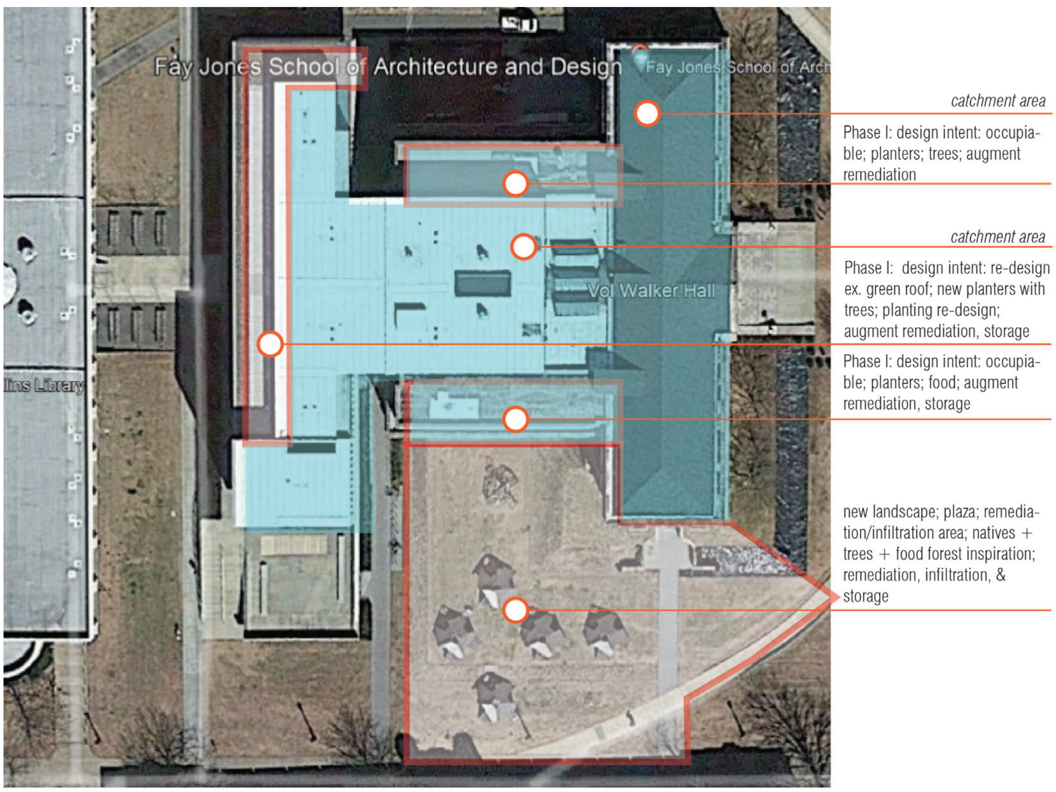


Figure 6: a diagram showing site programming.

Within the entire proposal are countless ways to engage the community. Signage will be provided where educational opportunities arise, and seating will be strategically placed close to ecological processes in order to foster investigation. Food production and distribution will connect the site to the larger campus community, and communal space on the south lawn will aide in interaction and relationships.

Design Benefits

Implementation of the design proposals have considerable impacts on the site. Given that few elements to remediate stormwater on the site exist currently, the following tables describe the increase in both runoff mitigation and storage capacity for use across the site.

Fay Jones "West" Green Roof

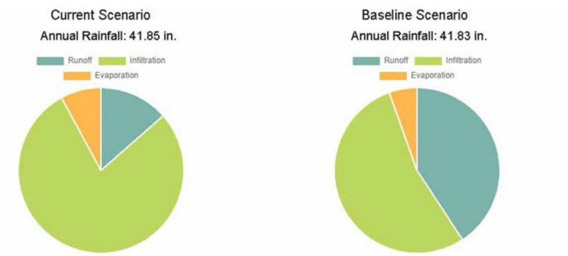
	Area	Green Roof	Impervious Cover	Storage Capacity		
Existing	6950 sf	1000 sf	5950 sf	0 cf		
Proposed	6950 sf	3800 sf	3150 sf	2400 cf		

Fay Jones "East" Green Roof

	Area	Current Plantings	Impervious Cover	Storage Capacity		
Existing	3900 sf	0 sf	3900 sf	0 cf		
Proposed	3900 sf	2350 sf	1550 sf	870 cf		

Fay Jones South Lawn

	Area	Current Pervious Cover (turf)	Impervious	Storage Capacity		
Existing	28850 sf	15900 sf	12950	0 cf		
Proposed	28850 sf	26750	2100	1900 CF		



Figures 7 and 8: data courtesy of EPA National Stormwater Calculator.

Seen above in figures 7 and 8, there is a drastic increase in storage capacity and a drastic decrease in impervious cover. In the baseline scenario, close to half of all stormwater on site is classified as "runoff". With our design proposal, that will reduce to less than an fifth, with the majority of stormwater being infiltrated.

Next, the biological engineering students modeled the design conditions using the information provided by the landscape architecture department. This included the new and improved green roof, rain garden, bioswale, storage, and permeable pavement features. Values that were not specified in the design were assumed based on EPA SWMM standards for each LID. The design results are shown below:

Subcatchment	Total Precip in	Total Runon in	Total Evap in	Total Infil in	Imperv Runoff in	Perv Runoff in	Total Runoff in	Total Runoff 10^6 gal	Peak Runoff CFS	Runoff Coeff
Subcatment	3.89	0.00	0.00	0.88	2.67	2.20	2.08	0.14	1.54	0.535
Roof	3.88	0.00	0.00	0.00	3.18	0.06	3.06	0.05	0.48	0.787

Figure 9: a table showing proposed conditions.

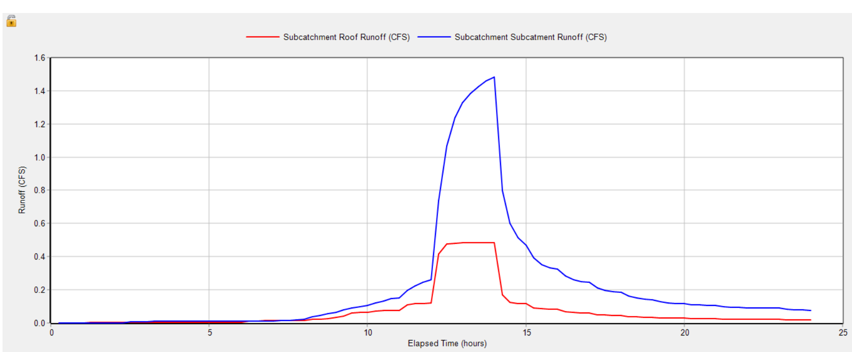


Figure 10: a graph showing proposed conditions.

Based on the values shown in each graph from SWMM, the total runoff from a 2-yr 24 hour storm was reduced from 6.72 inches to 5.14 inches (~ 23.5% decrease). The peak runoff on the ground sub catchment was reduced from 2.19 cfs to 1.54 cfs (~ 29.7% decrease) and the peak runoff on the roof was reduced from 0.57 cfs to 0.48 cfs (~ 15.8% decrease).

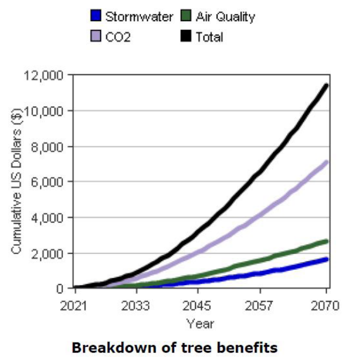


Figure 11: overall cost benefits of planted trees, provided by iTree.

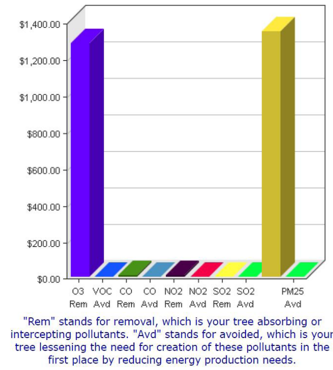


Figure 12: overall air quality benefits of planted trees, provided by iTree.

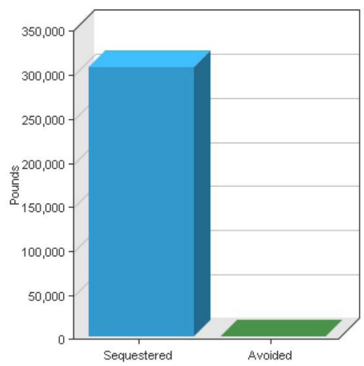


Figure 13: overall CO2 benefits of planted trees, provided by iTree.

In figure 12, "Rem" stands for removal, which is the tree absorbing or intercepting pollutants. "Avd" stands for avoided, which is the tree lessening the need for creation of these pollutants in the first place by reducing energy production needs.

The three graphs provided above, meant to be considered collectively with the data previously listed, describe the different benefits of the proposed tree plantings. This can be broken down into three categories: cost, air quality, and CO_2. Those are listed below.

1. Figure 8: over the course of the next 50 years, the proposed trees will provide a total of $11,416 worth of overall benefits.
2. Figure 9: over the course of the next 50 years, the proposed trees will remove (Rem) an estimated 1,213 pounds of pollutants.
3. Figure 10: over the course of the next 50 years, the proposed trees will reudce atmospheric carbon dioxide (CO_2) by a total amount of 306,649 pounds.

Not expounded upon in a graph, but also provided by iTree, is the data that suggests that over the course of the next 50 years, the proposed trees will intercept a total of 2,214,946 gallons of rainfall and help avoid 181,765 gallons of stormwater runoff.

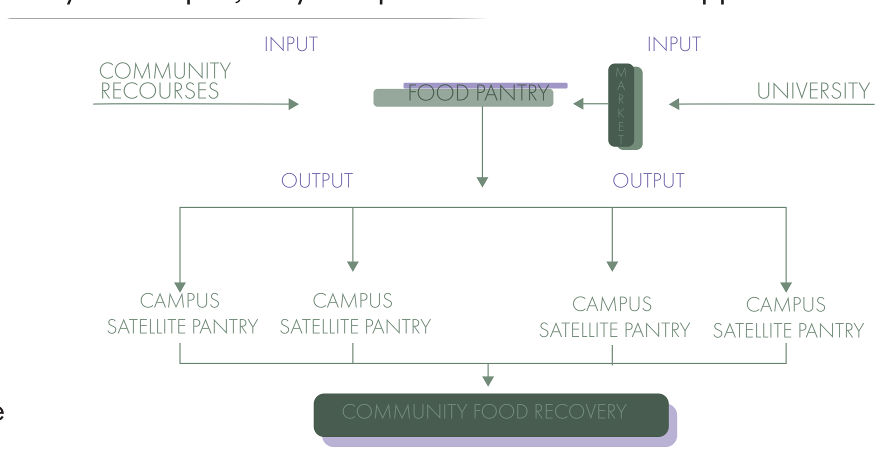
Partnerships

Recognizing that this is a collaborative process that requires input from multiple disciplines across the university and Northwest Arkansas, we identified strategic organizations to aide the team during the design process.

The Beaver Watershed Alliance

> works to proactively protect, enhance, and sustain the high water quality of Beaver Lake and its tributaries through voluntary best management practice implementation, outreach and education, and scientific evaluation. Tributaries of Beaver Lake such as the West, Middle, and East Forks of the White River, Richland Creek, and War Eagle Creek offer a diverse and stunning variety of aesthetic beauty, wildlife, and cultural heritage as they flow along their course to Beaver Lake. From Harrison, Arkansas to Westville, Oklahoma, over 420,000 people rely on Beaver Lake for drinking water, industry, and recreational activities such as boating, skiing, birding, and swimming. BWA provides strategic, valued, and meaningful programing to provide watershed landowners and environmental stewards with the resources they need to help protect the water quality of Beaver Lake and its tributaries. Planting native trees, shrubs, grasses, and wildflowers at stream restoration sites and upland areas of the watershed helps teach participants about the issues affecting Beaver Lake and gets them involved in actively stewarding the precious resource.

The Center for Community Engagement is a crucial collaborator on the Rainworks 2021 design proposal. Due to the fact that a large proponent of our proposed design is the alleviation of food insecurity at the University, it is of the utmost importance that we obtain direction from those most familiar with this issue. Not only does the CCE run the Jane B. Gearhart Full Circle Food Pantry on campus, they also provide students with opportunities for community service and public outreach. They were critical in helping us determine exactly how to get food distributed to those who need it most.



The University's Cooperative Extension Service and Campus Planning department were also very important in the design process. The CES helped the design team to determine which best management practices were the most beneficial to implement regarding agriculture, and the Campus Planning department provided important contextual information that helped determine specific design moves.

Professionals within the Northwest Arkansas area provided assistance as well. Lee Porter, owner of Ozark Greenroofs assisted in determining a plant palette and appropriate substrate for the west greenroof and John Scott, Fayetteville's urban forester, aided in providing a list of appropriate Arkansas native trees for the site.

Public Outreach and Education

A critical part of our design proposal is the involvement and education of the surrounding community. A pressing issue plaguing the general public is a lack of education regarding water processes. Most individuals simply do not know what stormwater runoff is or the strategies that can be implemented to help solve it. Our design will help to alleviate that issue. By implementing design features that combat stormwater runoff on a critical, critical, and highly visible site on campus, the mere proximity of the public will help to instill curiosity and intrigue. However, by also providing necessary literature that educates the community as to what exactly is taking place, they will begin to not only learn, but also be more empathetic and involved in the environment's future. Both the Beaver Watershed Alliance and the University's Center for Community Engagement will be important partners in these endeavors.

Borrowing from the permacultural construct of food forests, the design implemented on the south lawn will also be a crux of public outreach. The outcome here tends to speak for itself, but the distribution of locally grown food will first and foremost foster intimate community outreach and crucial opportunities for relationship. Not only will this provide nutrition for those who are food insecure on campus, but it will also allow interaction between individuals of different races, ethnicities, and socioeconomic status. Secondly, this food forest will provide instruction to those who desire to learn how to grow their own food through classes held on site.

Project Phasing

The project lends itself easily to considering either two or three phases. The first option—two phases—simply splits the project with a first phase completing the rooftop work and the second phase completing the at grade work. Given that the rooftop project is, in essence, two discreet areas of the School roof, each section of the roof could be phased in individually, with the at-grade work in a third phase.

Provided that the Fay Jones School of Architecture and Design is fully functioning nine months of the year, and partially occupied the other three months, preference and priority are given to the phasing scheme the causes the least disruption to the life of the School. A two-phase scheme has been selected, with large portions of the installation occurring during the warmer months, disrupting the academic semester schedule the least.

	January-May	June-August	September-December
2022		• Identify and assemble project team/stakeholders • Site assessments conducted • Funding partners and models identified (installation & maintenance)	• Design phase • Team/stakeholder meetings ongoing • Commence development of School support teams (student-oriented) • Refined cost estimation • Funding in progress (installation & maintenance)
2023	• Design/documentation phase • Team/stakeholder meetings ongoing • Commence development of School support teams (student-oriented) • Plant and other materials acquisition started • Final cost estimate • Commitments to funding in place (installation & maintenance)	• Phase I installation (green roofs) commences • Site preparation, demolition mid-May • Fabrication of site elements completed • Installation June-August • Maintenance schedule begins • Planting for first fall harvest completed, with student support and connections to campus food pantry established • Potential first market days held • Phase II preparation commences	• Phase II preparation continues • Planting continued for later fall harvests ongoing, with student support and connections to campus food pantry established • Additional market days held • Preparations for winter production in place
2024	• Phase II installation (south lawn) commences (spring) • Maintenance protocols and resources developed and in place • Rooftop food production enters its second season • Event planning for new south lawn plaza commences	• Phase II installation (south lawn) ongoing • Maintenance protocols and resources developed and in place • Rooftop food production enters its third season • Event planning for new south lawn plaza continues and finalized for Academic Year 24-25	• Phase II installation (south lawn) completed • Maintenance regime for Phase II South Lawn implemented • Events in plaza commence • Rooftop food production enters its fourth season

Construction Estimate and Projected Maintenance Costs

Cost estimations are provided by discreet site locations, as well as phase, and are based upon design development drawings, and reflect the precision allowed by estimating at this point of documentation. Standard industry conventions are used in calculating material quantities and estimating value-added costs such as fabrication or manufactured custom design elements.

Phase I: West Green Roof

Item/Description	Unit Quantity	Unit Cost/Multiplier	Total
Growing medium	21 yds	$75.00	$1,575.00
Material: steel; benches and planters	2600 sf	$3.00 sf	$7800.00
Fabrication: steel; benches and planters	2600 sf	3	$23,400.00
Plumbing reconfiguration and install		time/material allow	$5,000.00
Moss Green Wall	[need sf]	time/material allow	$10,000.00
Vegetated Green Wall	[need sf]	time/material allow	$5,000.00
Green Wall; neon logo	1	allow	$2,500.00
12' specimen trees, boxed or b&b	7	$350.00	$2,450.00
Herbaceous planting	1,650 sf	$2.50	$4,125.00
Supplemental irrigation system (drip)	1,650 sf	$1.75	$2,887.50
Mulch, if needed	1,650 sf	$.50	$825.00
Lighting design, materials, installation	1	allow	$5,000.00
10% contingency			$7,191.25
Total:			**$79,103.75**

Phase I: East Green Roof

Item/Description	Unit Quantity	Unit Cost/Multiplier	Total
Growing medium	9 yds	$75.00	$675.00
Material: steel; benches and planters	2640 sf	$3.00 sf	$7,920.00
Fabrication: steel; benches and planters	2640 sf	3	$23,760.00
Plumbing reconfiguration and install	1	time/material allow	$5,000.00
Pervious paving system	1449 sf	$20.00 sf	$28,980.00
12' specimen trees, boxed or b&b	7	$350.00	$2,450.00
Herbaceous planting	657 sf	$2.50	$1,642.50
Supplemental irrigation system (drip)	657 sf	$1.75	$1,149.75
Mulch, if needed	657 sf	$.50	$328.00
Lighting design, materials, installation	1	allow	$5,000.00

Item/Description	Unit Quantity	Unit Cost/Multiplier	Total
10% contingency			$7,825.58
Total:			**$86,081.33**
	Phase I Total:		**$165,185.08**

Phase II: South Lawn Plaza

Item/Description	Unit Quantity	Unit Cost/Multiplier	Total
Demolition and regrading	15,500 sf	$.50	$7,750.00
Pervious paving system	4700 sf	$20,00	$90,000.00
Material: steel; cisterns	3000 sf	$3.00	$9,000.00
Fabrication: steel; cisterns	3000 sf	3	$27,000.00
Material: steel; benches, planters	2700 sf	$3.00	$8,100.00
Fabrication: steel; benches, planters	2700 sf	3	$24,300
Rain garden boardwalk	1	allow	$10,000.00
Plumbing reconfiguration and installation	1	allow	$5,000.00
12' specimen trees, boxed or b&b	20	$350.00	$7,000.00
Herbaceous planting	11,300 sf	$2.50	$29,250.00
Replacement sod	900 sf	$.60	$540.00
Mulch	12,800 sf	$.50	$6,400.00
Lighting design, material, installation	1	allow	$5,000.00
10% contingency			$23,564.00
Total:			**$259,204.00**
	Phase I Total:		**$165,185.08**
	Phase II Total:		**$259,204.00**
	Project Total:		**$424,389.08**

Funding

Funding opportunities are identified and are closely related to and frequently flow through our projects partners (see “Partners” above). In addition, two opportunities exist within the Fay Jones School of Architecture and Design itself: potential philanthropic funding to the school, dedicated to the project or portions thereof, and student-funded gifts or memorials, designating particular design elements as “class gifts.” Major opportunities, however, exist with our primary partners, The Beaver Lake Watershed Alliance and the University of Arkansas’s Center for Community Engagement.

As a collaborative partner with the Beaver Watershed Alliance (BWA), avenues are opened to tap into federal Section 319 funding of the federal Water Pollution Control Act. This funding would not only provide means to construct low impact development elements of the design, but also meaningful work with the BWA in areas of stormwater education. BWA frequently works with the Arkansas Department of Environmental Quality, Water Quality Division, allowing access to resources at the state level. Conversation with the Executive Director of the BWA have suggested that the BWA and the Team could investigate opportunities under the American Recovery Act as well.

The partnership with the Center for Community Engagement is equally as engaging. The Center, which is completely grant-funded supporting a robust set of programming (including the Jean B. Gearhart Full Circle Food Pantry), has an extensive donor base from which to draw. In addition, the Center works extensively with The Wal-Mart Foundation’s NWA Gives program and Tyson Food foundations and corporate giving. While not a specific funding source, the Center also works with Americorps/Vista project.

The project also provides opportunities for educational and living expense funding for students. Specific funds for student assistantships to provide care and upkeep for the project can be established. Through the School’s network of alumni and identification of landscape professionals, practitioners, and suppliers, sponsored funding can be created to support a number of students.

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