Solar Powered Vegetable Wash Station

This is a project that aims to better understand how a solar powered wash station can be designed and implemented at LaFarm. While doing so we took into account the short term and long term effects of such an undertaking.

Bridget Walsh, Engineering Studies and Economics ’16
Shaun Gallagher, Engineering Studies ’16
Kevin Jackson, Engineering Studies & Geology ’16
Tien Tran, Engineering Studies & Economics ’16

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INTRODUCTION

College campuses across the country are making efforts to move towards a more sustainable, environmentally conscious approach to campus activities. This can be seen in the increased implementation of solar and wind power, recycling efforts and an emphasis on slowing climate change. The Lafayette College community, in a similar sense, also expresses this desire to prioritize environmental sustainability on campus.

Source: Lafayette LaFarm

Within Lafayette's sustainability initiative, LaFarm, the college's local farm, is the cornerstone of the Lafayette College Sustainable Food Loop. The campus Sustainability Food Loop aims to close the loop that includes food production, consumption and food waste. This is of growing importance on college campus' seeing how industrialized and and disconnected the food production process has become in recent years. LaFarm and Lafayette College aim to integrate curriculum and practice with regards to sustainable food production and consumption for the campus community and Easton community.

In order for LaFarm to achieve their goal of providing local produce for Lafayette College as well as serving as an educational tool for students and local farmers, improvements to their facilities must be made. Our capstone project this year is to examine how a solar powered wash station can be implemented into LaFarm. The solar powered wash station is a crucial component of LaFarm's daily activities and must be implemented properly in order for LaFarm to maintain and expand upon their current operations. Our research question can be articulated as follows: how can a solar powered wash station be implemented so as to ensure LaFarm's sustainable future while strengthening its relationship with Lafayette College as well as the Easton and Forks communities?

The goal of designing and implementing a solar powered wash station is that it will comply with the recent Food Safety Modernization Act (FSMA). The FSMA legislation requires farm and facilities to maintain safe food processes. Though LaFarm is currently exempt from this legislation, LaFarm's compliance will showcase its credibility in the small scale farming community. To further frame LaFarm as an educational template for community farms, LaFarm wants to finance the project without the help of donations from local farms.

Potential difficulties we may face in the design and implementation of a solar powered wash station will primarily be with compliance with new FSMA legislation. Other challenges we may face in the design of the wash station will be determining the model and capacity of the necessary UV filter and battery.

In order to implement and design a solar powered wash station at LaFarm, we must first consider many other factors including contexts such as social, policy, economic and technical. In the following analysis of what this installation should look like, our group has analyzed all components of the wash station at LaFarm and how it will effect the community and campus. At the conclusion of our analysis, we hope to have presented a well researched and articulated study of how a solar powered wash station should be designed and implemented to best fit the needs of LaFarm.

SOCIAL CONTEXT

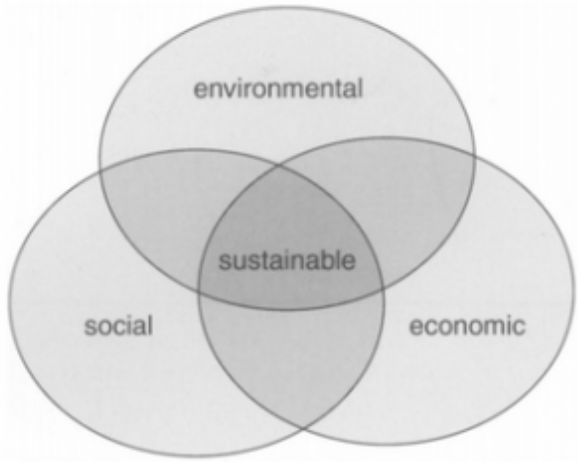


Figure 1 Three pillars of sustainability
Source: Maxwy L., 2006

In order to best understand how the solar powered wash station will serve LaFarm, it is important to first understand the value and role of LaFarm viewed through a series of contextual lenses. During the process of design and implementation of the solar powered wash station at LaFarm, we have defined the social context analysis to include four influential contexts that include historical, user, campus/community and environmental. While these 4 contexts shape our social context, the social context must be considered in conjunction with others to understand the role of this socio-technical system. Sustainability is not just a social or technical consideration but instead "to be sustainable something must be simultaneously economically, socially and environmentally sustainable" (Maxwy L., 2006).

Historical Context

When evaluating the importance of LaFarm and its mission, one must understand the historical context of small scale campus farms and how it ties into Lafayette's reasoning behind the expansion of LaFarm. Beginning primarily in the 1960's and 1970's, during a time of emphasis on social change (specifically in the engineering and industrial disciplines), questions regarding food production safety and sustainability began to arise. During this period arose questions by students on college campuses about where their food was coming from and how they could make this process not only more transparent, but also more sustainable. An early template of a sustainable, educational campus farm, the campus farm at Evergreen State College in Olympia, Washington, educated one of the first groups of students who were taught to experience farming. It emphasized that "sustainability is proposed as a tool to facilitate questioning, analysis and action. It is understood… as a *process* rather than a definitive end point and key to this process is opening up not only active engagement but also the construction of norms and agendas to all actors" (Maxwy L., 2006).

The efforts of Evergreen State College and its students to better understand how food is a socio-technical system that fits into everyday life is comparable to Lafayette College's efforts at LaFarm. With Lafayette College's history rooted in agrarian practices (Skillman, 1932, p. 67), students and faculty alike find it important to understand our relationship with food and the power that it can give local people and places.

The historical context of small scale campus farming ties in with LaFarm's educational initiative. The unique lessons that can be learned from working on a community farm are best articulated by Wendall Berry, author of "The Agrarian Standard", who noted that "a function of 'industrial education' over the years has been to 'preserve and protect an ignorance of local people and places'… This is how the worst of global and national economies operate. By contrast, in a local economy, people are more likely to ask and answer such questions as, 'Did I do that?' 'What will this do to our water supply?' or, 'Is it healthy?'. Participants in this economy will be less likely to accept damaging outcomes" (Bramwell S. et al, 2011).

After having discussed with Sarah Edmonds her vision for LaFarm, we have a better sense of LaFarm and its place within its own timeline of continued improvement and grander aspirations. Sarah hopes that an environmental campus will one day be built on Metzgar Fields with LaFarm as its main attraction. This will enable more students to play larger role in the production of fresh local produce. This undoubtedly informs our design and implementation of a wash station. Based on Sarah's vision for LaFarm, there are both short-term and long-term goals that need to be met.

Campus/ Community Context

At it's core, LaFarm is a community farm. The purpose of LaFarm is to provide a space for community members, students and faculty to come together to farm, learn and work together towards a common goal of local sustainable farming. The combined contribution and expectations of Easton community members and Lafayette community members places community and campus context at an increased importance.

Important to take into consideration is that LaFarm grows and sells much of their produce to Bon Appetite, Lafayette's dining services. This give students and Bon Appetite a direct stake in how LaFarm is operated. The use of locally grown food contributes to Bon Appetite's initiative to be a customer and supporter of local farmers. This initiative is an important aspect to the socially and environmentally concerned member of the campus and community.

The goal of LaFarm is to be an educational farm for both the community and campus and has no desire to take away business from other small farms in the area. That being said, LaFarm does hope to achieve recognition and respect for being a revenue gaining, sustainable farm that does not require donations to function. This self-sustaining image is desired in order to be used as a template for other community and campus farms who hope to also incorporate technology, specifically solar powered, into their operations. Lafayette College and LaFarm recognize this need and take it into consideration when analyzing the funding stream for this project.

User Context

The solar powered wash station that we are planning to design and implement into the workflow of LaFarm will affect all the users of LaFarm. No longer will the farmers at LaFarm have to use the existing, decaying wash station that currently stands on the LaFarm property behind the toolshed . The wash station that is currently at LaFarm was assembled with donated materials, connected via hose to the water system and does not meet new regulation for small scale farms. With this new wash station, LaFarm will achieve more credibility in the farming community and can be used as an educational template for other small scale farms.

LaFarm is unique as its users of the land and equipment include students, staff, faculty and community members. This diverse audience is important when taking into consideration how the users may accept and use a new wash station. LaFarm and the wash station should fit the mold the Easton and Lafayette community has set forth in creating an educational and sustainable farm.

"Users" of LaFarm one degree removed, the students and other individuals who consume the food from LaFarm, hold a stake in how LaFarm is run and especially in the technology that cleans the food they are eating. When dealing with something as personal as the food that people consume it is pertinent that we understand the role that locally grown food plays in a campus structure. The food loop that Lafayette and other small scale farms are trying to achieve is not a singular process but instead a system and it is important to understand "the notion of sustainable food, recognizing that food, like everything else, is embedded in a host of heterogenous processes and contexts" (Maxwy L., 2006).

Environmental Context

The environmental context is an important, overarching context that introduces the policy and technical analyses to follow. Driving the environmental aspect of this project is the environmental benefit resulting from a local, sustainable farm. Within Lafayette and LaFarm's food loop, food is produced, consumed and disposed in a cycle that reduces waste, unnecessary chemical use and lessens travel emission. On an environmentally aware campus like Lafayette's, LaFarm's food loop holds value to students in a time in which "a growing number of consumers and producers in supporting organic farming and a host of other 'alternative' food networks" (Maxwy L., 2006).

Seedling started at Banger High School Greenhouse- example of strong community oriented program that also serves an educational small scale farm template Source: Bangor Area High School greenhouses grow food, minds

The incorporation of the existing solar panels connected to the irrigation system we plan to use emphasized the self-sustainability of the wash station. Using no outside power source, the wash station will not be consuming power to wash vegetables. This contributed credibility to LaFarm as a self-sustainable farm and allows it to be better used by other small scale farms as a sustainable template.

In conjunction with LaFarm's educational objective, students learn to farm within the constraints of their existing environment. These constraints include limitations associated with climate change, natural stress as well as time and space constraints (Stinger L. C. et al, 2008). The lesson that LaFarm can offer to its student, faculty and community farmers is an important one as the reality of climate change is affecting lifestyles, ecosystems and policy around the word. The environmental educational experience achieved from small scale farming reach far beyond the just community or campus. This benefit is very well articulated in "The Evergreen State College" chapter of *Fields of Learning* "When a student manages the on campus farm stand, he or she is helping provide vegetables to the campus community in a way that directly substitutes for vegetables imported from California or elsewhere, sidestepping the industrial food chain with all its petroleum dependency, trade inequities, and pollution woes" (Bramwell S. et al, 2011).

POLICY ANALYSIS

The order of the political analysis relative to the social analysis section of this report is not arbitrary. While local, state, and federal policies can force LaFarm's short-term and long-term goals, an understanding of LaFarm's function within the context of its relationship with the Lafayette and Easton communities influences how policies are interpreted. This section seeks to articulate the policies that shape the short-term and long-term visions for LaFarm. Additionally, this policy analysis addresses the stakeholders, and policy-actors most likely to influence the decision-making process and eventual execution of a wash station.

Policies Warranting & Influencing the design of a Wash Station:

Food Drug Modernization Act (FSMA)

The Food Drug Modernization Act (FSMA) was signed into law in 2011 in an effort to better prevent food contamination rather than respond after the fact. As a result, new food safety standards have been updated and implemented to address the practices associated with growing, harvesting, washing, packaging, and preparing of foods. The act does not adopt a one-size-fits-all policy and recognizes that requirements necessary for a large scale facility imposed on small scale operations could be detrimental to the agriculture industry. In short, LaFarm is exempt from most requirements imposed on large-scale operations (>$1,000,000 in annual revenue), but nonetheless serves as a template for neighboring small-scale farms that will increasingly have to comply with federal oversight of good agricultural practices.

The most pressing regulatory pressures imposed on ambitious small scale farms include the need to ensure safe food practices during the growing, harvesting, washing, packaging, and preparing stages of on-farm food preparation. FSMA creates new regulations for produce production and food safety measures for facilities. In general, this refers to two specific rules established by FSMA: the Preventative Controls Rule and the Produce Rule.

For facilities that manufacture, process, pack, or hold human food should follow requirements imposed by the Final Preventative Controls Rule. This rule revises Hazard Analysis and Risk Based Preventative Conrols as well as Current Good Manufacturing Practice (GMP) requirements. Fortunately, farms similar to LaFarm are exempt from this rule as a result of meeting the definition of a *farm* rather than a *facility*. A *primary production farm* is an "establishment under one ownership in one general physical location devoted to the growing" and "harvesting of crops," and may also pack and hold "raw agricultural commodities" (FDA, Sept. 2015).

Most importantly, all farms should comply with the Final Rule on Produce Safety (Produce Safety Rule) that regulate aspects such as agricultural water, biological amendments, farm health and hygiene, as well as equipment and buildings that impact the growing, harvesting, packing, or holding of produce. The main points of this rule are to ensure that agricultural water is treated and tested both on a routine basis (a minimum of one sample per year); soil amendments are used appropriately; actions are undertaken to prevent contamination of vulnerable sprouts; that workers are adequately trained with regards to health and hygiene; and that measures are taken to prevent contamination of produce by equipment, tools, and buildings (FDA, Nov. 2015). This is informative for LaFarm, because it establishes agricultural water testing and enhanced hygiene as the two issues most inadequately addressed.

Produce Safety Standards under FSMA require that LaFarm's harvesting practices comply with the Produce Safety Rule. Additionally, the FDA has provided a Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables. In the case of small scale farms akin to LaFarm, facilities can meet standards by achieving Good Agricultural Practices (GAP) and Good Holding Practices (GHP) certification by a third party-auditor. Applicable requirements expressed in the audit checklist for GAP & GHP certification pertaining to a wash station includes the ability of the farm to ensure that the water used is "microbially safe," that source water in the packing operation is "potable" (USDA, 2014). If a wash station is to serve the dual purpose of packing, additional requirements need to be met for the development of a packing house. These include that the packing facility be "enclosed" placed away from employee facilities, and garbage receptacles (USDA, 2014).

While many other facets of LaFarm are the under scrutiny of FSMA and GAP & GHP guidelines, only the most pressing issues should be addressed in an effort to make LaFarm more compliant with federal regulations. It is because of this that the development of a wash station is necessary. LaFarm and many others like it must be able to test the water that is used to wash harvested produce.

Building Codes

The Pennsylvania Department of Labor & Industry exempts agricultural buildings from having to meet construction codes within the Commonwealth of Pennsylvania. *Agricultural buildings* refer to:

"A structure utilized to store farm implements, hay, feed, grain or other agricultural or horticultural products or to house poultry, livestock or other farm animals, a milk house and a structure used to grow mushrooms. The term includes a carriage house owned and used by members of a recognized religious sect for the purposes of housing horses and storing buggies. The term shall not include habitable space or spaces in which agricultural products are processed, treated or packaged and shall not be construed to mean a place of occupancy by the general public" (DLI, 2008).

A wash station and similar operating facilities on a small scale farm like LaFarm most likely fall under the definition of *agricultural building* given that they are distributing raw agricultural products rather than "processed, treated, and packaged" products.

Policy Actors:

Lafayette College represents the most influential organization. Within Lafayette College, there are extensive groups of interconnected departments and faculty with direct control over the daily operations and long term goals of LaFarm. Most importantly, all of these divisions work together to finance and implement projects at LaFarm. These include:, Sarah Edmonds, Garden Manager; members of the LaFarm Advisory Board; the Office of the Provost; Dining Services; the Department of Facilities Planning and Construction; academic departments such as Engineering Studies, Civil & Environmental Engineering, & Environmental Science and Environmental Studies; as well as the Plant Operations Division.

In addition, student organizations represent key groups of interested students with an uncanny ability to raise awareness within the Lafayette community. These include: The Lafayette Food and Farm Cooperative (LAFFCO); Lafayette Environmental Awareness and Protection (LEAP); and The Society of Environmental Scientists and Engineers (SEES).

Apart from Lafayette College, additional individuals and institutions both legally and fiscally have a notable say in the daily and long term operations at LaFarm. For example, the FDA Food Safety Modernization Act (FSMA) sets the standards for facility registrations associated with the manufacturing and preparation of produce and is enforced by the FDA and third party organizations. These include: The Ludwick Family Foundation; Art Hendrickson '51; Bon Appetit Management Company; US Food and Drug Administration (FDA)

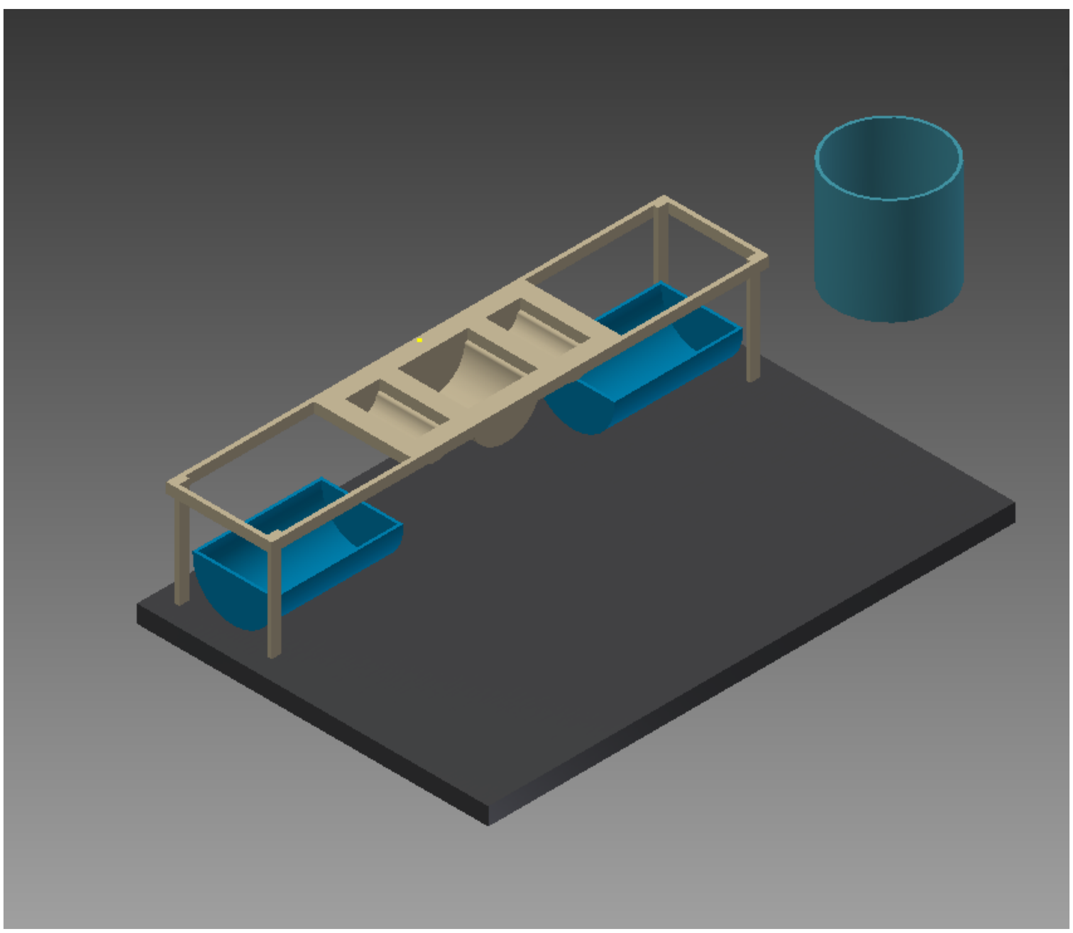
Before considering the technical design and the economic analysis, it is pertinent that an understanding of the policies most heavily influencing the design process are understood. In this sense, the political context informs the decisions made in the rest of the report. The social analysis involved understanding the social, historical, and environmental factors that define LaFarm: its relationship with the communities of Lafayette College and Easton and, thus, its purpose. Lafayette's rich historical ties to agrarian practices, environmentally conscious student body, and role as an educational institution as well as a natural lab for innovation heavily influences any project that is undertaken. Based on the social analysis, LaFarm is understood to be a template for other small-scale farms. This informs any group tasked with improving LaFarm to consider LaFarm as a "primary production small-scale farm," which informs further decisions on the basis that certain federal regulations under acts such as FSMA are exempt for LaFarm and the other small-scale farms it hopes to inform.

Technical Analysis

When designing the physical implementation of this project, our goal has been to combine durability with affordability, while taking into account how the station will be used at LaFarm and where it fits into the farm's food cycle. We were instructed by Sarah Edmonds to use treated wood materials in the construction of the station to avoid deterioration (which was a problem with the old station), and our choice of all materials used reflects this desire to build a structure that will last. There were many decisions that were influenced by wash stations developed previously (Godfrey); some of which, were GAP certified.

Construction:

The first step will be to lay out a concrete monolithic slab foundation. We were expecting to have this done by a contract worker who would be able to do so properly, but we may be able to have a professor on campus do so instead, thus avoiding some labor costs. Either way, we want this foundation to rise at least 6 (but preferably 8) inches off of the ground, and to be 10×15' in size. Doing so will protect the lower part of the structure from moisture. Also, we want the top of the foundation to be sloped slightly as a preventative measure to keep water from pooling in the corners of the station.



(Self Designed)

- *A computer model representing the concrete monolithic foundation with the wash station components on top*

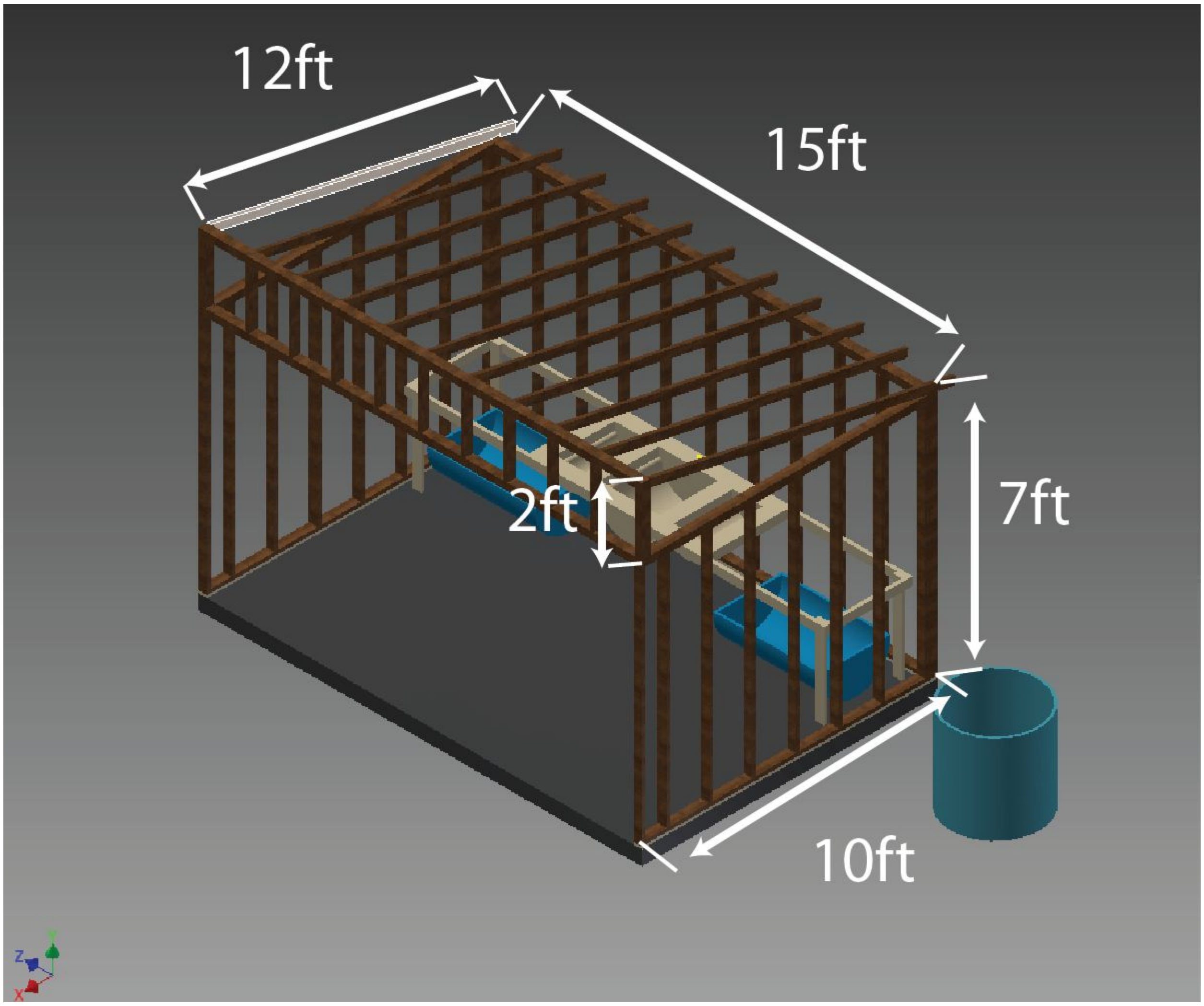
While laying the concrete, we want the workers to insert lag bolts into the slab before it dries, so that when it does we can bolt the structure directly to the slab for a secure connection. This will dispel any concerns about wind moving the structure.

Next we will lay vinyl composite 1x4x8 boards along the edges of the foundation where the walls will be put up. These will function as the lower of the two layers that will form the lower sill plate. We've chosen vinyl composite material since this will be the part of the structure that comes directly in contact with the foundation, and therefore will be most exposed to moisture.

Next, the walls will be constructed on the ground, and then raised onto the foundation and secured together (though the builder may choose instead to simply build the walls upon the foundation). We've chosen a three-wall design, with two walls along the 10ft borders of the foundation and the third along the 15ft border. These walls will include, in ascending order, the upper part of the lower sill plate, the studs (spaced 16in), and the upper sill plate. We realize that not all studs will fit 16in apart, so the measurements will start at the corners for the 10ft walls (leaving the smaller space at the open end). It does not matter which side the measurement starts on the 15ft wall. All components mentioned will be 2x4x8 pressure treated boards, chosen for additional moisture and deterioration protection as well as low cost.

The corners where the 10ft and 15ft walls connect will be composed of three 2x4in studs nailed together, with each wall going off of these corners. The ends of the 10ft walls will be comprised of one additional stud to mark the end of the wall. Though the lower sill plate will consist of a pressure treated board on top of a vinyl composite board (once the walls are erected), the upper sill plate will be two pressure treated boards nailed together, with the seams staggered for added strength.

The roof will be a single-slope design, directing water to the rear of the structure (behind the 15ft wall). The construction will utilize 2x4x12 pressure-treated boards acting as cross members running the length of the roof. They will be raised on the front side (above the open wall) by a small 2ft wall constructed on top of an upper sill plate that will run between the ends of the 10ft walls, thus technically functioning as the lower sill plate for the smaller wall. The smaller wall will also have an upper sill plate (each of these sill plates will be constructed in the same manner as the upper sill plates on the 10ft and 15ft walls, with two pressure treated boards nailed together), which the cross members will be connected to after the ends have been cut to the appropriate angle (78.9 degrees). The cross members will rest on the 15ft wall on the other side, with a crow's foot notch cut into each at the point of contact.



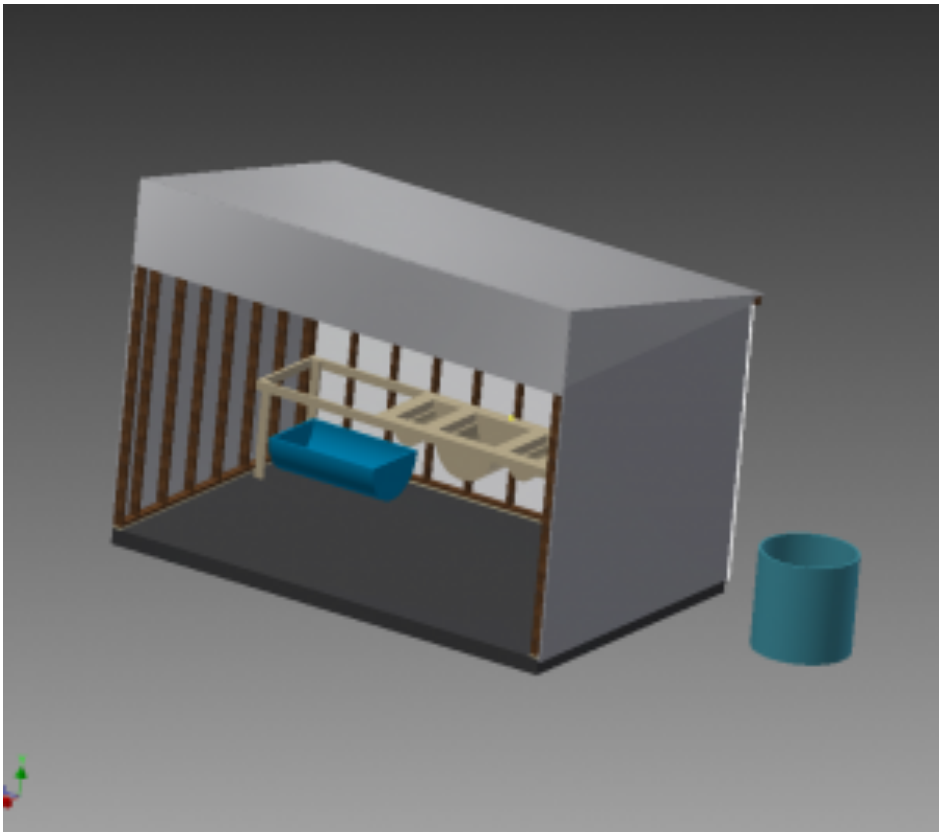
(Self-Designed)

- *The model now includes the framing of the walls depicted in the analysis*

Finally, the 10ft and 15ft walls as well as the roof will be covered with galvanized corrugated steel. In order to fasten the corrugated panels, 1in strapping boards will run the lengths of the walls horizontally, with a vertical spacing of 1ft between each board. The corrugated panels will be fastened directly to these strapping boards, with 1-rib overlaps along the walls and 2-rip overlaps on the roof (for extra water protection). Since the corrugated panels come in 8ft lengths, a secondary row will need to be laid on the lower part of the roof. It will be fastened underneath the ends of the first row, to ensure water runs off the roof without passing through the seam. Also, the lower part of the panels covering the walls will run past the lower sill plates and overlap the concrete foundation, providing further moisture protection for the lower part of the structure.

To let a little extra light in, the triangular section above the 10ft walls will be covered in clear corrugated plastic instead of steel, and will still have the 1-rib overlap.

To provide some ventilation to the structure during the summer months, soffit paneling will be placed vertically along the 2ft roof wall, alternating between solid soffit panels and ventilated soffit panels.



(Self Designed)

- *The model now includes the final construction of the three-wall structure with the wash station inside*

With the structure now complete, we must focus on the station itself. The industrial sink that will function as the wash station will be positioned in the center of the table that supports it, with two open sections on either side that will be covered in chicken wire. These open sections are where vegetables will be placed to dry. Underneath these sections will be the halves of a 55-gallon barrel, cut in half to catch the water dripping off the vegetables. The sink will also drain into these barrels, which will each be connected with PVC piping to a larger external reservoir. Collecting the water in this manner will prevent it from simply draining into the nearby stream and contaminating the stream with pesticides and other chemicals.

The design we have presented in this technical analysis describes how we believe that the engineering team should execute the construction of the structure; however, additional structural analysis is still necessary.

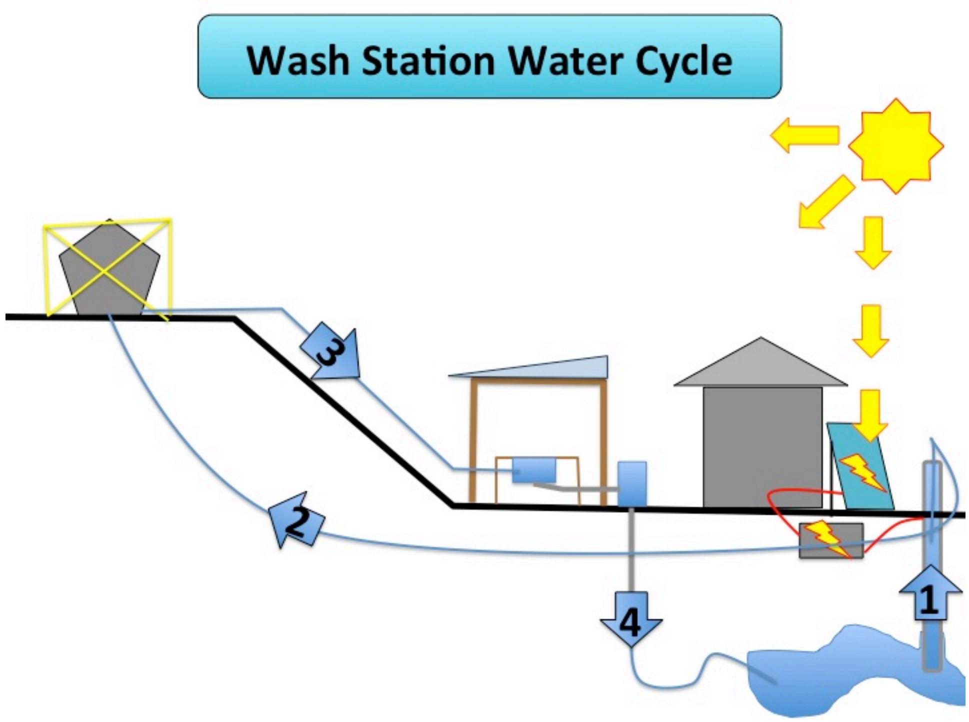
Water Cycle:

A key component of the wash station design is to ensure that an efficient and sustainable water cycle is established and maintained. The current Art Hendrickson irrigation system enables the commercial plots to receive drip irrigation, and delivers water throughout LaFarm to communal watering stations that can be used by any member of the LaFarm community.

The irrigation system was developed by a Lafayette faculty member, Professor David Brandes. The system uses solar panels to run a pump that extracts water from a well and feeds it to a collection container on top of a nearby hill. The water is then gravity fed to watering stations throughout LaFarm. While this system has been successful in supplying water to LaFarm, the addition of a solar powered wash station that complies with FSMA standards to the system requires modifications to its current design.

New issues that arose when attempting to meet regulatory standards included an inability to collect runoff for chemical analysis, as well as a lack of a external battery for the solar panel to ensure additional solar-powered technologies (such as a UV filter) can simultaneously run with the water pump. The new design keeps these features in mind as well as the main contexts that have most heavily influenced the decision making process. These include adhering to the social, environmental , and historical values that have shaped LaFarm and contributed to its campus-wide and community-wide impact. All in all, the development of a water cycle that can ensure a sustainable treatment of the water while ensuring access for the entire LaFarm community is paramount.

The Following figure shows the 4 main stages of water flow in our system:



- *Step 1: Water is pumped up from a well using a solar powered water pump that also get sanitized through a solar powered UV-filter.*
- *Step 2: Water continues to pump vertically up to a water collection container.*
- *Step 3: Water is gravity fed downhill to be used both on the LaFarm's commercial and communal plots as well as at the wash station adjacent to the tool shed and solar-pv panels.*
- *Step 4: After having been used at the wash station, water is gravity fed through a PVC installed plumbing system into a collection barrel. The water is tested to ensure that it is safe enough to be properly released back into the environment.*

Now that we have looked at the wash station and the structure that will enclose it, we must look at our water source, how it works, and how it will be powered. As the name of the project suggests, our energy will come from solar panels. These panels already power a water pump, but with our project we will add a UV filter to the system. After the filter is added to the existing gravity-powered system, we will connect our wash station to complete the system.

The UV filter will replace the current method of water purification (which entails the use of bleach poured directly into the well). The UV filter will be placed right after the pump, so that purified water is pumped up the hill into the reservoir. Placing it near the pump will minimize the amount of extra circuitry that will need to be included, since the pump is already powered by the solar panels. Due to the extra demands the UV filter will place on the electrical system, a deep-cycle battery will be installed between the solar panels and the pump/UV filter to ensure the system can operated all day with the stored capacity.

In regards to selecting a UV water filter and battery, our group would refer the civil engineering construction team to Viqua in order to select a model that is compatible with the flow rate of the existing water pump. We faced difficulties in calculating the necessary flow rate because the current pump is submerged.The link to the UV filter producer can be found here: (http://viqua.com/help-me-choose/)

Similarly, the deep cycle battery's price can varies based on the capacity needed. Hence, once the UV filter is selected. We recommend the implementation team to further analyze the power input for both the UV filter as well as the irrigation system and select the desired battery capacity. The link to a battery producer can be found here: (http://www.wholesalesolar.com/)

We hope that by using materials that are durable yet affordable, and by ensuring the wash station functions as an integral mechanism in the overall process at LaFarm, our design will fulfill the needs of the farm as it grows and develops for years to come.

ECONOMIC ANALYSIS

Wash-station construction

Within the 2014 LaFarm's Reports, one of the LaFarm's vision for the future is to have an improved infrastructure and one feature is the wash station. In addition, this will also help the farm meet its standards under FSMA regulations. Hence, tying closely with the Technical Analysis and Social Context for sustainability design, we are choosing materials that have affordable costs while ensuring that our design is environmentally conscious.

Under the Food Safety and Modernization Act, it is in our best interest to construct the three walls extending from the original location of the wash station and a concrete floor along with slanted slab drainage system that would meet the code for regulations. As mentioned in the Technical Analysis, the spring 2016 Civil Engineering class will be the main constructors of the wash station as well as the concrete flooring and wall enclosure so labor costs are currently not incorporated in our calculation. As seen in the spreadsheet that we attached below , we estimated that this would take around $5,915 for the concrete flooring and three walls construction along with stripping boards and vinyl sheets to act as the wash station roofing. The construction of the wash station would cost approximately $813 with materials also listed below. In regards to selecting a size and capacity of a UV water filter, our group would refer the civil engineering construction team to Viqua in order to select a model that is comparable with the flow rate and the solar panels power output. As for the external battery, we faced difficulties in analyzing the buried water pump as well as the actual power output of the PV panel. This is an important aspect to consider as we select the appropriate deep-cycle battery to convert AC to DC current and power both the irrigation system and UV filter. Hence, we refer the spring project construction team to Solar Battery to consult the appropriate type, capacity and prices once these informations are determined.

Because a lot of our construction design and planning placed more emphasis on sustainable, low-cost, and easily replaceable materials, we are expecting the servicing and maintenance costs of the facility to be minimal and not much different from what we have before.

Wash Station & Drainage			
Materials Cost	Unit	Unit Price	Total Price
Plastic Lumber 2x4x12	10	$48	$480
Chicken Wire: 24inx 50ft	1	$8	$8
Double Basin Kitchen Sink	1	$110	$110
Staples	3	$3	$9
Screws	3	$10	$30
PVC piping 1 1/2in x 10ft	2	$6	$12
45 degree elbow 1 1/2in	4	$13	$52
32 in. x 80 in. Woodgrain Door Slab	1	$38	$38
		Sub-Total	$739
		w/ 10% contingency	$813
Refurbished Materials			
Water collection basins (Coke Barrel)	2	FREE	
Concrete floor and Facility Construction			
Material Cost	Unit	Unit Price	Price
flooring			$1,750
2x4s	48	$48	$2,304
Vinyl Boards	12	$30	$360
corrugated sheets	45	$20	$900
Stripping Boards	21	$3	$63
		Sub-Total	$5,377
		w/ 10% contingency	$5,915
		Total Material Cost	$6,728

Budgeted Construction Cost

Another important thing that we need to consider is the vision of LaFarm in the near future. Per Sarah's guidance and request, we are expecting the funding sources for this project will be coming from grants that LaFarm currently has. In addition, LaFarm also would like to add the green house to extend its farming season which is also included with a feasibility study in the LaFarm Green House Capstone Group . This is important for us to consider because the wash station can also be integrated with the large scale green house if LaFarm decision is to obtain one. As the result, we are proposing this cost estimate base on what we have so far as a short term vision for the improvement of our current wash station without taking into account of the integration with the green house project. Keeping this in mind, the long term vision of integrating with the green house is not impossible as our design for the wash station can be easily moved or reconstructed if needed.

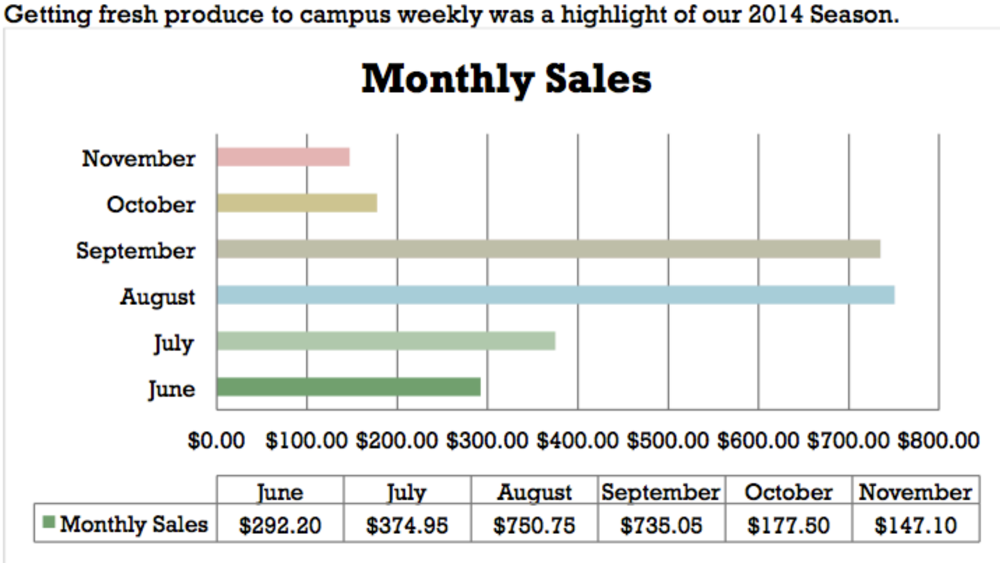
LaFarm's 2014 Financial Performance

It is also imperative that we also take a look at LaFarm's financial review to gauge how our farm is currently operating in order to ensure its sustainability status. The attachments below are LaFarm's End of 2014 Year Financial Review and The Academic Year Spending by Percentage. These informations gave us a closer look at LaFarm on a micro-economics level. As we have noted before, the main goal of LaFarm is to serve as a educational model to promote sustainability on our campus as well as other small scale farmers in the nearby local areas so profit margin is not heavily focused as a result.

Attached below are the sales of LaFarm's produce for the dining halls on Lafayette campus. Although as we discussed in the policy analysis that LaFarm is considered to be a small scale production facility, the production scale is still important as LaFarm moves forward in the near futures. Currently, LaFarm financial standing is looking healthy in its current operating budget. The farm actual balance is currently under its forecasting costs and the monthly sales of produce is increasing within the growing season with August and September being its sale peaks.

Campus Dining Hall Vegetable Delivery

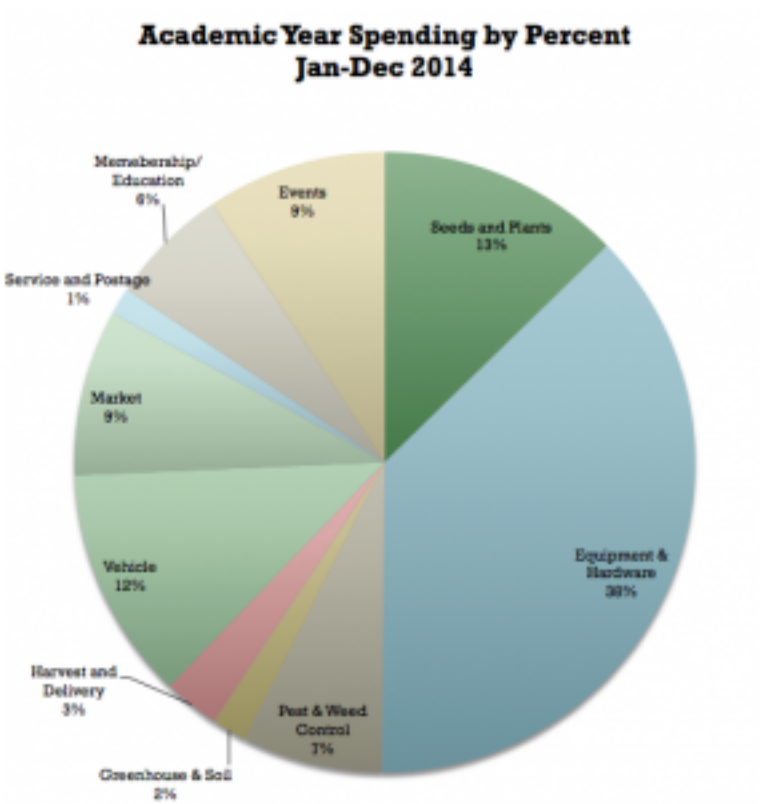
Getting fresh produce to campus weekly was a highlight of our 2014 Season.



(Reference: Edmonds, 2014)

LaFarm End of Academic Year Financial Review			
Categories	Projected	Actual	Balance
Farm Labor Needs			
Labor	$38,800.00	$38,800.00	$0.00
Sustainability Funds from Office of Finance and Administration	$4,000.00	$4,000.00	$0.00
Seeds and Plants	$1,800.00	$1,749.03	$50.97
Supplies			
Equipment & Hardware	$5,200.00	$5,157.17	$42.83
Pest & Weed Control	$1,000.00	$1,006.61	($6.61)
Greenhouse & Soil	$500.00	$248.58	$251.42
Harvest and Delivery	$400.00	$398.80	$1.20
Vehicle	$2,200.00	$1,675.00	$525.00
Market	$1,300.00	$1,190.59	$109.41
Service and Postage	$200.00	$197.20	$2.80
Membership/Education	$1,000.00	$855.68	$144.32
Events	$2,000.00	$1,292.00	$708.00
Infrastructure	$50.00	$0.00	$50.00
Community Garden	$50.00	$0.00	$50.00
Total	58500.00	$56,570.66	$1,929.34

Figure 2. LaFarm End of Year Review (Reference: Edmonds, 2014)



(Reference: Edmonds, 2014)

Conclusion

After analysis of the design and implementation of a solar powered wash station at LaFarm we have concluded that it is feasible to install a FSMA approved technology into the workflow of LaFarm. After extensive research and investigation of the social and policy contexts and how it thus influences our economic and technical analyses, we believe that the students of the civil engineering class next semester will be prepared to construct the wash station.

The wash station design that we have proposed in our report is both economically and technically feasible to be used as a template for other small scale farms. The materials utilized in our technical analysis are of low cost and can be purchased from Home Depot near campus.The design we have presented in this technical analysis describes how we believe that the engineering team should execute the construction of the structure; however, additional structural analysis is still necessary.

Though LaFarm has funds available to construct a more sophisticated facility, our design is in line with LaFarm's goal of providing a template of how other small scale farms can comply with FSMA regulation with the use of renewable energy. Additionally, with the use of purchased materials, rather than donated items like in the past, LaFarm shows its credibility as a self-sustaining farm. This credibility supports LaFarm's mission to provide locally grown food to the community and campus without competing other farms in the area.

The wash station that we have designed incorporates all aspects of the facility and the water cycle that must be taken into consideration when approaching a system of this nature. The facility, which includes the floor, walls, roof, drainage and table are designed with the needs of the expected user in mind. Each step of the workflow is considered in order to design a solution that will increase the productivity of the wash station while meeting FSMA regulation. We believe that this achieves our goals set out in the social and policy analysis.

Within the system of the the solar powered wash station that must be considered to produce a well-analyzed design is the water cycle. The water cycle, traced from the well, through the UV filter and irrigation system and back to the wash table is a crucial aspect of this design. The UV filter ensures quality of water and allows the wash station as a whole comply with FMSA regulation. The waste water from the sink is then collected, tested and fed back into the swale to keep the cycle in motion. In conjunction with the use of the solar panels, our wash station allows the water cycle to fit within the sustainable objective of this project and LaFarm.

The solar powered wash station that we have designed and proposed in this report will allow LaFarm to expand it operations in the future. The solution that we have arrived at has been considered in both the short term and long term as the best option for LaFarm as it moves to expand its facilities. With the installation of this system, LaFarm can more efficiently serve its existing customers as well as enhance upon the experience of the community members who utilize LaFarm. Through the implementation of a wash station, LaFarm will be able to continue its mission to maintain the Lafayette food loop in an educationally beneficial and sustainable fashion.

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