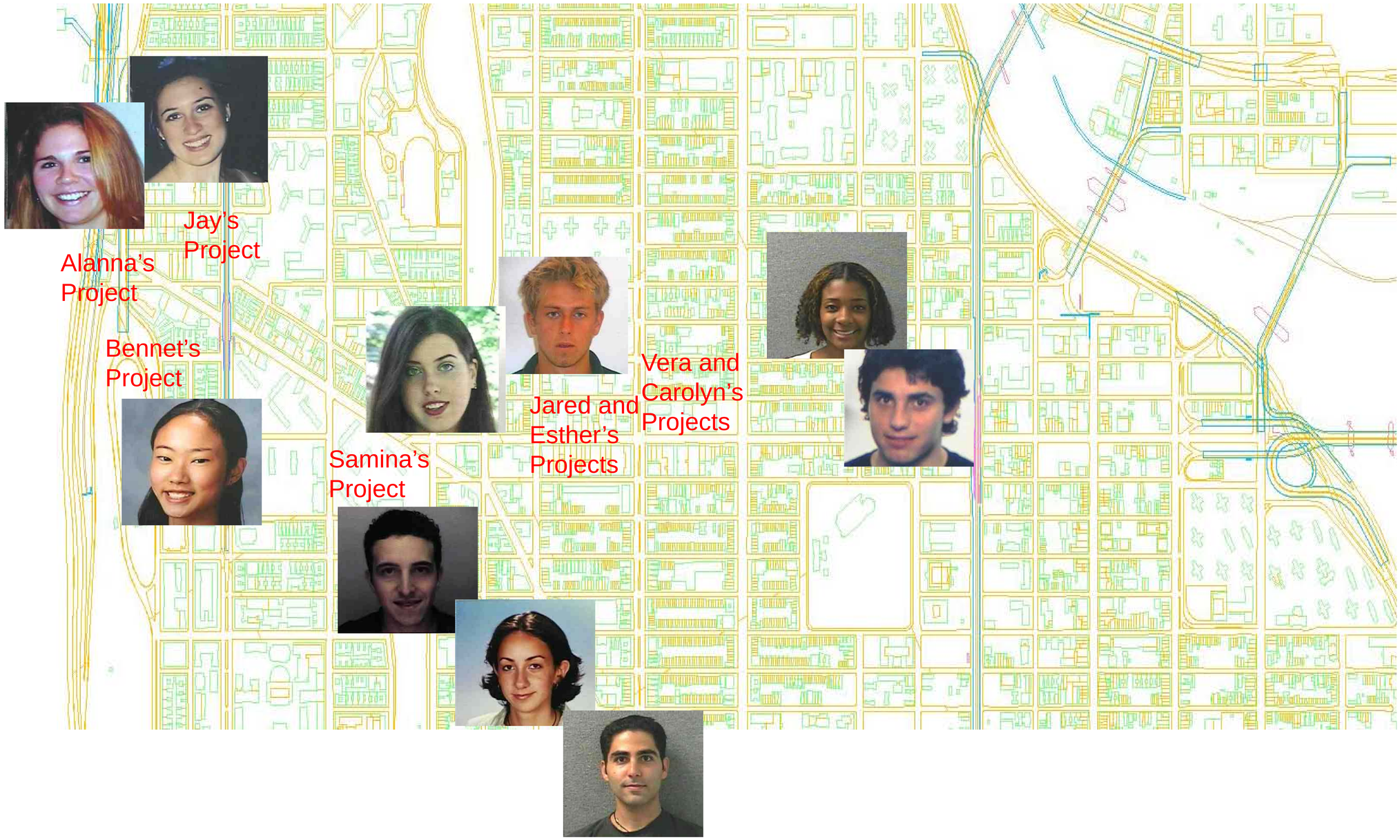
125th Street Harlem: Waste, Water and Energy

Can we Halve the Street?

Design

Technology


Jay's Project
Alanna's Project
Bennet's Project
Samina's Project
Jared and Esther's Projects
Vera and Carolyn's Projects

Urban Ecology Studio: 125th Street Smart Street Proposals

Riverside Drive Viaduct Rainwater Collection System

Civil Engineering Student: Christen Currie **Architecture Student:** Alanna Talty **Studio Critic:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

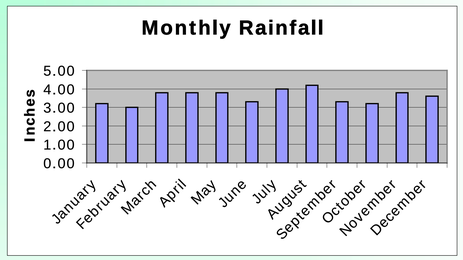
Site Description

The Riverside Drive Viaduct is located at 125th street and 12th avenue. It is approximately 1800 feet long, 56 feet wide and 78.13 feet from the ground. Each year tones of water flows off the bridge during big storms and goes unused. The proposal is to use this water and convert it into electricity using water turbines.

The follow is a design for a water collection system that leads into a series of water turbines.

Rain Collection

The following chart show data for the average amount of rain collected per month in New York City based on data collected the last five years.



An assumption was made that estimated the occurrence of four storms a month that last approximately four hours each.

It was decided that one turbine could be place under each bay of the bridge. Rainwater will then be collected from the area of bridge above each bay and filter into a collection tank. The tank will have a slope and will act as a large funnel that feeds into to the water turbine. Above the tank will be a filter system of either high permeable gravel or a filter screen so that the water is filtered of large dirt particles before it flows through the turbine.

Flow Rate:

The average amount of water collected per month was multiplied by the area of the bridge that the water would be collected. This area for each tank would be the section of the bridge above each bay, which would be 3000 square feet or 278.7 square meters. Using the assumption of four storms a month that last for four hours, a flow rate was calculated by dividing the volume per storm by time. The following chart shows the flow rates per tank for each month.

FLOW RATE

	ft^3/s	m^3/s
Month	**Flow Rate (Q)**	**Flow Rate (Q)**
January	2.22E-04	3.93E-04
February	2.08E-04	3.69E-04
March	2.64E-04	4.67E-04
April	2.64E-04	4.67E-04
May	2.64E-04	4.67E-04
June	2.29E-04	4.06E-04
July	2.78E-04	4.92E-04
August	2.92E-04	5.16E-04
September	2.29E-04	4.06E-04
October	2.22E-04	3.93E-04
November	2.64E-04	4.67E-04
December	2.50E-04	4.42E-04

Energy Created (Turbine Energy Equation):

The energy created from this flow rate depends on the height that the water will fall from. In other words, the head of water (H_T). The total head would be the height from the bottom of the collection tank to the top of the turbine as long as we take the datum to be at the top of the turbine. This was calculated by taking the total height of the bridge and subtracting the depth of the water tank. (An extra foot was subtracted from the height to account for the tank suspension system and a filter system so that the water that flows through the turbine is clean.) The total head turned out to be 22.9 meters.

The energy or the rate of work that the turbine delivers was calculated with the following energy equation:

$$\omega_T = \rho * g * Q * H_T * \eta_T$$

ω_T = rate of work

ρ = Density of water (1000kg/m^3)

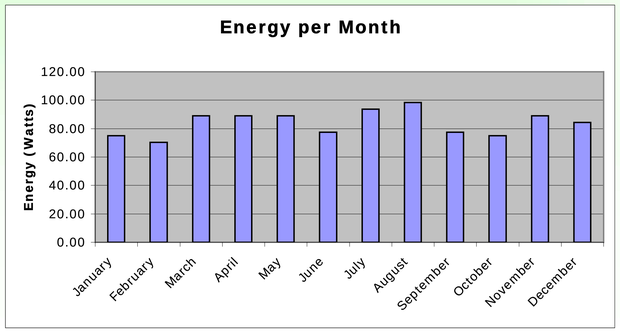
g = Gravity (9.81 m/s^2)

Q = Flow rate (m^/s and varies per month)

H_T = Total Head (23 m)

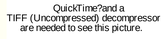
η_T = Turbine efficiency (0.85)

The following chart shows the energy created per month for one turbine.



Proposed Energy Use:

The average amount of energy produced from one turbine is roughly 84 Watts. This would be perfect to provide electricity for lighting in the vertical farm or on the bridge. The energy from one turbine could be used to feed two low energy flood lights like show in figure 1. These lights are 42 watts each with reflects and can replace up to a 175 watt flood light.



Another option is to feed six 14 watt light bulbs show in figure 2.

Figure 1: Flood lights

Figure 2: 14 watt bulb

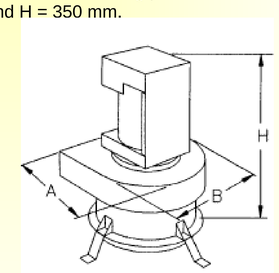
Reference: http://www.buylighting.com/low_energy_light_bulbs.htm

Turbine:

The best turbine for this system was an impulse turbine. Impulse turbines convert the pressure of the water to kinetic energy with a nozzle and directs the water onto the turbine blades. The blades are curved and forced to rotate with the change in momentum caused by the water jet. The spinning of the blades is essentially force that is acting through a distance therefore causing work or energy.

The specific turbine used in the system is a Pelton wheel. In this design the jet water flows tangent to the path of the blades. It has spoon shaped blades around the edge of a wheel that are mounted in pairs.

This turbine produces up to 500 Watts and weighs 24 kg. The dimensions of the turbine necessary for this system refers to the following picture.
A = 300 mm, B = 400 mm, and H = 350 mm.



Pipe Diameter:

The pipe diameter was designed to ensure that the pressure going into the turbine stays positive. Bernoulli's equation shows that the energy going at the top of the pipe is the same as the energy at the top of the turbine. Assuming that the datum is taken at the top of the turbine and the pressure and velocity of the water is zero when it enters the pipe the equation can be rearrange in order to solve for the pressure of the water as it enters the turbine. The results of the calculation show that the diameter of the pipe has to be greater than 60 mm.

$$P = \rho * g * [H_T - Q^2/(2A^2 g)]$$

P = Pressure

ρ = Density of water (1000kg/m^3)

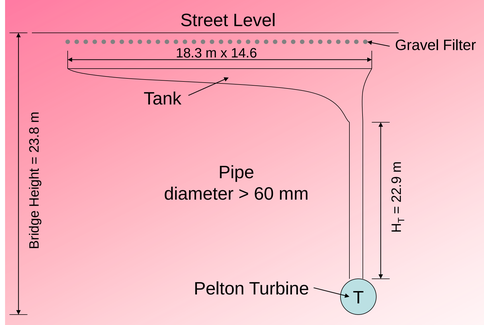
g = Gravity (9.81 m/s^2)

H_T = Total Head (23 m)

Q = Flow rate (m^/s and varies per month)

A = Cross-section area of the pipe

Overall Design for One Turbine:



References: 1: http://www.onlinelawyersource.com/news/btex.html 2. Engineering Investigation at Inactive Hazardous Waste Sites - Phase II Investigations Carroll Gardens, Final Report, 1990. Roux Associates Inc., New York 3. Gowanus Read Hook Neighborhood History Guide, The Brooklyn Historical Society, 2000. 4. Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicologic polycyclic aromatic hydrocarbons (PAHs). Atlanta, GA: U.S. Department of Health and Human Services, Public HHealth Service. http://www.atsdr.cdc.gov/tfacts69.html. 5. Revised Remedial Work Plan 124-136 Second Avenue, Brooklyn New York, 2000, AKRF Engineering, P.C., New York.

Urban Ecology Studio: 125th Street Smart Street Proposals

Digesters: Making Energy from Food Waste

Civil Engineering Student: Katy Schulte **Architecture Student/s:** Samina Iqbal, Alanna Talty **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

Introduction

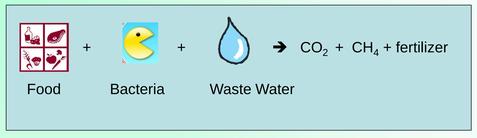
The New York Department of Sanitation collects over 12,000 tons of residential and institutional refuse and recyclables per day. The city's businesses, whose waste is collected by private carting companies, generate another 13,000 tons per day. One of the problems of having so much waste in NYC is that it must be taken away to other parts of the country due to the high cost and scarcity of land in the city and the surrounding suburbs. The transportation and land filling costs alone cost New York City approximately $250 million last year. Along with the transportation direct costs there are the indirect costs to the environment associated with the land filling itself and the pollution caused by the transportation. By the year 2015 New York City has hopes to reduce these costs. Amendment; Introduction 95: encourages NYC to deal with its own garbage. A beginning step in this process is taking care to reuse all the city's waste the is possible. Recycling metals, plastics, paper, and glass is one step; but another step would be to reuse food waste.

Approximately 10% of the city's waste is food waste. Food waste has a higher fraction of degradable or volatile makeup of any of the other elements that compose solid waste. This is due to food's carbon (sometimes known as organic) structure. In the process of degradation, energy can be produced as an added bonus. With energy costs skyrocketing, why throw away energy? Two ways to utilize carbon for energy are through direct combustion and anaerobic digestion which produces methane, an energy source that can be stored.

This poster discusses anaerobic digestion as a means for saving money by reducing wastes and saving and reducing energy.

Digesters

Anaerobic digesters mimic and hasten the natural anaerobic process. Putting organic wastes (manure and vegetable matter) into insulated, air-tight containers called digesters allows special bacteria to break down the structure of food into carbon dioxide (CO_2), methane (CH_4), and a sludge that can be used for fertilizers or pumped back into the waste water treatment process.



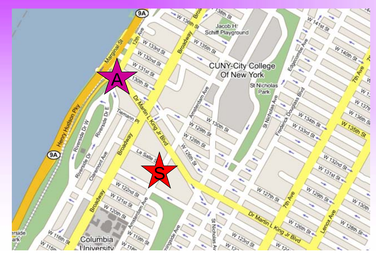
The type of digester chosen for this project is a continuous-load digester. These digesters have a continuous low flow input and mixing, so that gas can be produced continuously.

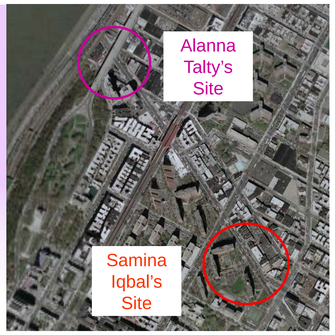
The digester is fed with a mixture of waste water and food waste, which is called slurry. Slurry must have a 30:1 Carbon to Nitrogen ratio. Food has a ratio of 40:1 and raw Sewage has a ratio of 16:1. Therefore, the food to water ratio must be 1:1.4.

Inside the digester, each daily load of fresh slurry flows in one end and displaces the previous day's load which bacteria and other microbes have already started to digest. Each load progresses down the length of the digester to a point where the methane bacteria are active. At this point large bubbles force their way to the surface where the biogas accumulates. The gas mixture is approximately 60% methane and 40% carbon dioxide.

When designing a digester there are a few rules. 75% of the reactor volume must be airspace and the remaining space is the volume of slurry in the tank necessary to meet the optimal residence time (Tr) of 25 days. Digesters need reinforcement beams on the interior to hold the structure together. The digesters must also be heated to an even 40 degrees Celsius to accommodate the bacteria and must be insulated. Insulation material must be unable to trap gas in porous spaces as this will cause explosions. Styrofoam is a cheap and simple insulating material.

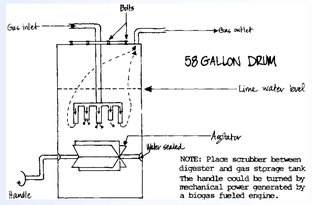
Site Locations:





Uses of Gas:

The biogas can be separated or not separated depending on its final use. For our needs the gas will be separated using a lime CO_2 scrubber. The biogas will flow into the lime tank and the CO_2 will be trapped in the lime while the methane bubbles out and is collected and stored.



CO_2 Scrubber/Filter

After separation, the methane can be burned directly for heat (like as in a boiler,) burned for light, stored for future use, or compressed to power heat engines. Methane contains 4450 kCal/m3 of energy potential. Depending on the efficiency ratio, this potential energy can be converted to electricity or heat.

For Samina Iqbal's project the methane will be direct flared into a boiler. A boiler burning methane obtains approximately 70% of the energy potential and turns it into heat via a direct flare. For Alanna Talty's project the methane will be used to generate electricity. A converted diesel engine burning methane obtains approximately 50% of the potential energy and turns it into electricity.

After separation the CO_2 can prove to be useful as well. The CO_2 can be re-harvested from the lime and used to make dry ice or sprayed on plants to help growth. In 1961 at the University of Michigan, plants that were grown in an increased CO_2 environment (0.04percent) showed an increased yield.

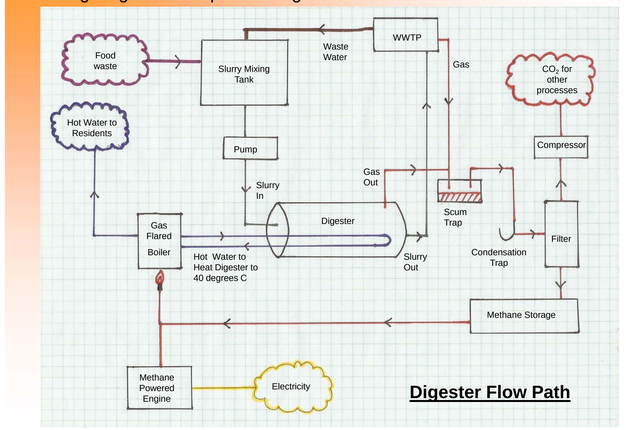
Reactor Design:

The reactor design was based on a balance that considered the number of chambers needed to meet the volume requirements, auxiliary equipment needed, and spatial restrictions of the sites. More chambers provide back up in case of a defective digestion, which would require that chamber be taken offline. However more chambers require more auxiliary equipment which would require greater capital and maintenance costs. The following is a list of inputs and outputs used in the design of the digesters.

	Input	Output
Waste Estimation	Population (Samina) Restaurant Foot Print (Alanna)	Volume of Food Waste Volatile Solids
Gas Production	Temperature Gas Constant Volatile Solids	Methane CO2
Energy	Methane From WWTP + Food Waste (Samina) Methane from Food Waste (Alana)	kW
Collector Design	Volume of Food Waste	Volume of Collector
Digester Design	# of Reactors wanted Volume of Slurry per Day Radius of Digester	Length of Digester
Pump Design	Slurry Flow to Each Digester	Energy Consumed by Pump

Flow Chart:

The design digester flow path is diagramed below.



Costs and Benefits:

There are two types of costs and benefits associated with this project:: direct and indirect. Direct costs/benefits are listed in the tables below and deal with the costs of buying equipment, and potential benefits of energy production and other outputs. The indirect costs and benefits are the those that have no market value but are no less important.

Direct Costs and Benefits:
With this system, New Yorkers would be reusing food wastes to provide energy.

NYC Waste Export (tons/day)	Cost of Trash Export in 2004	Cost to Export a ton of trash	Samina's Trash Volume (tons)	Samina's Savings	Alanna's Trash Volume (tons)	Alanna's Savings
10,978	$ 250,000,000	$ 62.40	339.7	$21,192.38	7,899.3	$492,844.74

Below is a table of the direct savings for trash removal and energy production.

	$$ Saved Per Year by Not Exporting Food Waste	$$ Saved Per Year by Producing Your Own Energy	Total $$ Saved Per Year
Alanna	$492,844.74	$133,498.93	$626,343.67
Samina	$21,192.38	$11,483.75	$32,676.14

Indirect Benefits:
The indirect costs associated with this project mostly deal with that of the environment and human health. How much is cleaner air, water, and land worth? How much is human health worth?

Waste that is brought to landfills degrades into a liquid called leachate that collects in landfills. Leachate contains broken down foods, toxic metals and other unpleasant ingredients mixed with water. If there are holes or holes form over time due to neglect, this leachate will leak into the local groundwater. This groundwater contaminates the local lands as the water is no longer drinkable. New Yorkers are indirectly contaminating the lands of other states with its garbage. By reducing wastes sent out of state, we reduce pollution and come closer to meeting Amendment; Introduction 95.

Also in a landfill, methane, a green house gas, might form and simply be released into the atmosphere. Other gasses that would be reduced in this process would be the carbon monoxides, carbon dioxides, and fuel particulates from the transportation of the wastes to the far off landfills. Harlem has the highest rate of childhood asthma in the country. What price could one put on cleaner air to the lungs of these children?

References: L. John Fry, "Methane Digesters For Fuel Gas and Fertilizer" http://www.journeytoforever.org/biofuel_library/MethaneDigesters/MD1.html. Peace Corps, The Biogas/Biofertilizer Business Handbook, 1985, http://peacecorpsonline.org/messages/messages/2629/2023122.html . Vesiland, P. Arne, Solid Waste Engineering. Brooks Cole Publishing, Pacific Grove California, 2002. Verderflex, "Peristaltic Pumps", http://www.verderflex.com/ .Caterpillar, "Gas Generator Set'" http://ifs.sim1.net/images/cstmr/PP8HN/LEHE5104%20final.pdf

Urban Ecology Studio: 125th Street Smart Street Proposals

LONG-SPAN STRUCTURES: BRIDGING THE GAP

Civil Engineering Student: Yungmoon Chang **Architecture Student/s:** Bennet Hu **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

Site Description

The western-most portion of 125th Street is a particularly interesting location because it is one of the last remaining large gaps in the Hudson River Valley Greenway. Providing a tangible connection from 125th Street to the park would encourage circulation to that area. In addition, increased movement in the neighborhood would help attract Investment to the 125th Street corridor west of Broadway.

Site History

125th Street has not always been the African-American cultural mecca that it is known as today. Celebrating African-American culture and history is now integral to the success of 125th Street. While many changes have occurred over the years, there exists room for improvement in certain categories. In terms of economic development, the westernmost portion of 125th Street is an area that has not yet been fully utilized. Underdeveloped and assuming the role of dead space, it does not currently encourage circulation, and therefore it does not promote its connection with Riverside Park. Additionally, the forcing out of local businesses has begun to be a large problem for Harlem, and the acceptance of this new space as room for expansion could aid with this situation.

Our idea to address these issues involves a spatial and physical bridge between 125th Street and Riverside Park. Visually bridging Harlem with the park will encourage circulation on the westernmost portion of 125th Street. This in turn will encourage economic development, and allow businesses being forced out to occupy a new space. This additional circulation will enhance a typical tourists Harlem experience. New technologie will also be employed in the structure which could create a sense of pride for Harlem residents with regard to their ability to stay current with new developments and ideas.

In short, it is hoped that a bridge from 125th Street to Riverside Park will create more circulation in the westernmost portion of 125th Street. This increased circulation will enhance tourists' visits, economic development, and create pride for residents.

Technological Frontiers:

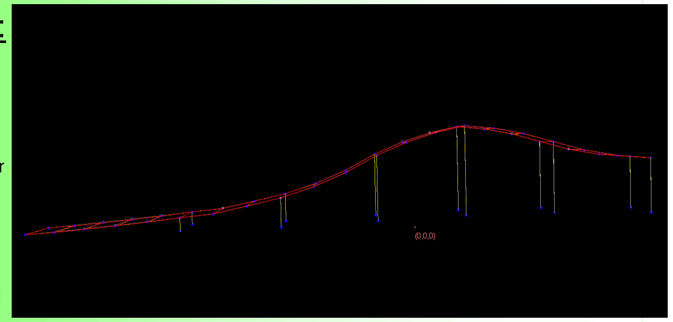
Several new innovations are included in the superstructure.

Deck properties: In an effort to allow light to pass through the deck of the bridge, new materials were investigated. Ideally, the new deck of the bridge will be structurally strong, but have the ability to let light pass through, turning the underside space of the bridge not into dead space, but as valued and novelty properties.

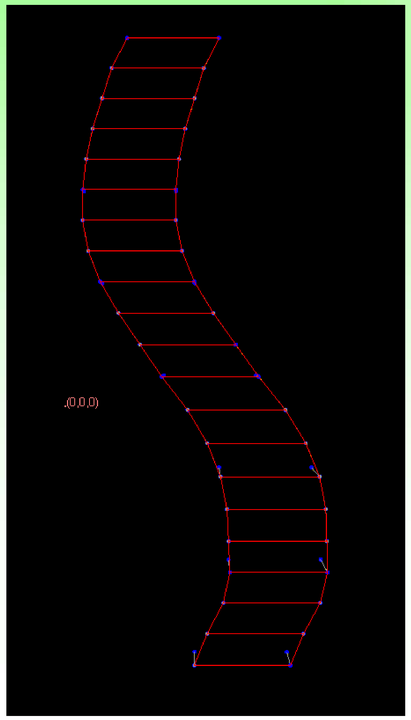
Environmental awareness: A proposed rainwater collecting system will be incorporated. Making use of gravity as the principal force causing water to flow down pipes attached to the bridge allows for the greatest product yield with least input. It should be noted that while the pipes must slant downward, they do not necessarily have to be directly attached to the deck of the bridge. In other words, the pipes may be attached away from the deck at different lengths, allowing the overall slope of the entire system to remain constant.

Swimming in the Hudson: Located at the connection of the bridge to the park, an infinity pool could be installed so as to create the illusion of swimming in a body of water directly connected to the Hudson. Water sources could include purified water from the rainwater harvesting, or filtered water directly from the Hudson.

Structure Proposal:

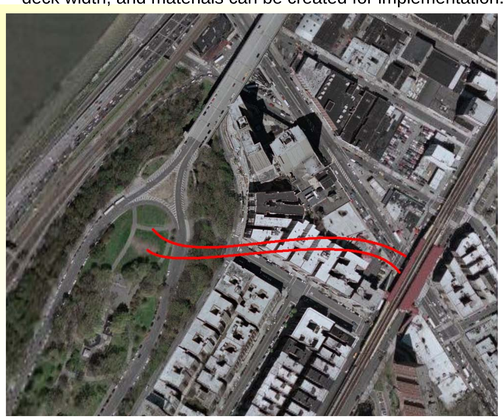


In an attempt to create another visual layer of space, the deck of the bridge will ideally be as wide as possible, hopefully on the order of magnitude of 50-100'. It will slope upwards towards the center of the bridge, then fall again back to elevation 0, at which point it will reach the park. Supports shall be placed at every thirty feet to ensure stability of the structure. Having supports at these locations should also be helpful in relieving some of the stress on the deck, and thereby allowing deck materials to be used that will not necessarily be as strong as concrete, but will still work while being visually pleasing. For purposes of analysis, we will assume the bottoms of these connections to be fixed, and the real-life structure should be built to ensure this connection. Another note is that while the bridge being analyzed has a deck only 30' wide, whereas the final product may employ either several bridges connected together, or placed at different angles so as to cross. This does not affect the original analysis, because adjoining structures can be joined using connections which essentially will not transfer any load or moment through them, making hinges of sorts. Therefore, ideally this bridge should be used as a model for the final structure, not as the final design. Once the basic structure and forces have been analyzed, more specific structures in terms of placement, deck width, and materials can be created for implementation.



Placement of structure:

The bridge is intended to connect 125th Street to Riverside Park. The edges should be located at the highest portion of the northernmost part of the park, and the intersection of Broadway and 125th Street. Elevations may be varied as needed per requirements of surrounding buildings and zoning restrictions. Additionally, more bridges may need to be either attached or built at different angles to fully capture the effect of creating another visual plane of space for the area. This will not affect the basic structural calculations for this sample structure, as hinged joints may adjoin two bridges.

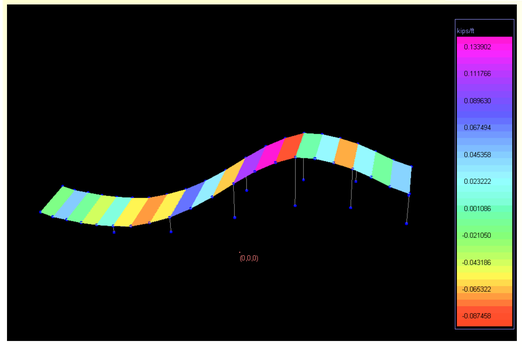


Analysis Using Larsa2000:

Stresses in plates:

Maximum stresses were picked out of the results for Larsa. These stresses, along with their locations in the plate should be used to calculate what materials may be used within the deck. The stresses for the columns were also calculated, but as these are not terribly important to the overall aesthetics of the bridge, they are not shown here. These columns will most likely be created from concrete of varying sizes, differing as the forces differ. It should be noted that the units of output are kips per square foot, and that these forces are generally acting over a length of approximately 10'.

Plate	Loc	S yy (ksf)	Princ Mx
1	Bottom	0.15	0.97
2	Bottom	-2.12	0.62
3	Top	1.40	1.56
4	Bottom	-1.58	-0.12
5	Bottom	-0.13	0.54
6	Bottom	0.80	1.21
7	Bottom	0.94	0.94
8	Bottom	-3.93	1.12
9	Top	-5.47	0.25
10	Bottom	3.65	3.96
11	Top	3.93	5.51
12	Top	-4.37	0.42
13	Bottom	2.20	2.85
14	Top	0.34	1.02
15	Middle	-0.53	-0.12
16	Middle	0.95	0.95
17	Top	0.86	1.36
18	Top	1.45	3.01
19	Top	1.05	2.94
20	Bottom	3.69	6.43



Note:
Live load =
0.075 ksf (pedestrian)
Deal load =
0.100 ksf (planters)
Self-weight

Deck thickness is assumed to be 6" concrete for purposes of obtaining a rough calculation.

Technological Innovations:

Possible deck materials: clear plastic beams, glass, SPACIA (evacuated glazing glass)

Rainwater collection system:

Infinity pool:

Benefits and Impact:

-The visual connection will physically tie 125th Street to the park
-This bridge will increase circulation in an underdeveloped part of 125th Street.
-With this new stimulation will follow economic development for 125th Street as a whole.
-New technological innovations will create a sense of currency and pride for 125th Street.
-This superstructure will serve as an attraction for tourists.

References: 1: http://www.dot.state.mn.us/bridge/Manuals/LRFD/section04.pdf 2. Google Earth 3.0.0762, released by Google, Inc. Nov 17 2005 3. http://www.hobbyengineering.com/H2234.html 4. http://www.nsg.co.jp/en/corporate/buisiness/build.html 5. http://www.pbs.org/wgbh/pages/frontline/shows/secret/oral/rat06.html

Urban Ecology Studio: 125th Street *Smart Street* Proposals

Wind Flow Analysis

Civil Engineering Student: Elie-Issa El-Khoury **Architecture Student/s:** Alanna Talty, Samina Iqbal **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

Description of Site

The general site is located in Harlem, New York between 124th St. and 126th St. It extends primarily from the shore of the Hudson River on the westerly side, to Lennox Ave on the easterly side. The specific points of interest for this investigation are the Viaducts found on the west side of the site, and the intersection of Amsterdam Ave. and 125th St. The focus at the site of the intersection is the structures found at the location, including their topological features and relative positioning to one another. The site of the Viaducts will directly relate to the physical orientation and form of the bridge. Due to the implications that will be drawn from this analysis, the sites towards which the results may be applied are far reaching. Consequently, the set of locations involved in this analysis is not discretely limited.

Overhead view of sites marked in red

Project Objective

This project will identify high volume wind flow and high wind speed locations throughout the site in order to assess the possibility of harnessing significant wind energy through a series of wind turbines. While the methods of implementation of delivering generated energy are extensive, this study will not address those methods; rather it will gauge whether such issues are relevant under the scientific generative capacity of the site, and the efficiency with which such energy-generating systems could operate.

Design Considerations

Architectural design schemes have suggested that such energy generation be expended towards powering existing structures onto which the windmills could be mounted. Alternatively, the windmills could serve as autonomous structures that store generated energy and disburse it to the local community. The extent to which the structures are powered by the windmills is a function of the energy consumption of those structures, and the energy generation possible under the localized wind conditions. Consequently, this technology may serve to either entirely complement or merely supplement the current demand of energy. Independent of this analysis, it would be prudent to acknowledge the complications associated with socio-political objection to the implementation of this technology in the site.

Tools Implemented/Method of Implementation:

The primary method of analysis of wind flow was done using multiple computer aided design software. The first step was to create a 3-dimensional scaled model of the site using *AutoCad*. Next, the model was exported into a second 3-D modeling program called *Rhinoceros,* which is capable of reading and writing a .IGS file type. In this program, the site is reduced to its most rudimentary form with the elimination of all extraneous information not pertinent to the development of local wind patterns, such as magnification of wind speed or deflection of wind current.

Once the model was been refined, it was exported as an .IGS file and imported into a meshing program called *Gambit*. Gambit acts as an intermediary in analyzing wind flow*.* It was initially used to generate a meshed volume around the model of the site that could serve to make analysis possible by means of a finite elemental analysis. The solver of this mesh would have been the program called *Fluent*. Unfortunately, in spite of numerous attempts to create a detailed enough mesh around the model, *Gambit* was incapable of providing the level of accuracy necessary for a proper analysis.

As an alternative the model was imported into an airflow analysis program called *Airpak*. This program does not have computing capacity as vast as *Fluent's*, but it is still capable of generating a meshed volume and sufficiently analyzing the site in a wind-tunnel-like system.

A cross-section of the Viaducts was modeled directly in *Airpak*, while the site of the buildings at 125th St. and Amsterdam Ave. was imported from *Rhinoceros.* Due to the complexity of both of these sites, the reduction of the site to variables of significance is not a trivial task. It requires an understanding of the fundamental principles that govern airflow. An investigation of these idealizations are offered as part of this analysis.

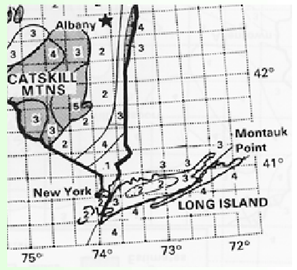
Extraction of Significant Variables/Input Data:

The Viaducts consist of a series of repeating arch structures with nearly identical cross-sectional geometries. The extraction of key information contained in this geometry is based on the direction of incidence of typical wind flow with the bridge. It was therefore essential to identify the primary wind direction that was to be assumed throughout the analysis. Furthermore, the magnitude of this wind would be essential in quantifying the amount of usable energy that may be generated. Of course, the same wind direction and speed was assumed for the analysis of the Amsterdam and 125th intersection. The following is a tabulated representation of wind information that was used in this analysis[1]:

Mode Wind Direction	Ratio of Occurrence (% of days sampled)	Avg. Wind Speed (mph)	Viaducts Wind Speed w/ Vert. Height Adj. (mph)	Amst. & 125th Wind Speed w/ Vert. Height Adj. (mph)
SW	27.10%	9	10.2	11.9
NW	35.60%	9.4	10.6	12.4

The wind data was taken from 118 samples gathered intermittently over the past decade. The primary wind direction for this analysis was determined to be the mode wind direction in the data, or the direction which appeared most frequently. Because the data was gathered proportionately over each year (approximately monthly), this method of determining a center value is reasonable and relatively accurate. An average of the wind speeds associated with this wind direction was taken as well. The two wind directions tabulated above are associated with the major synoptic wind directions prevalent in New York.

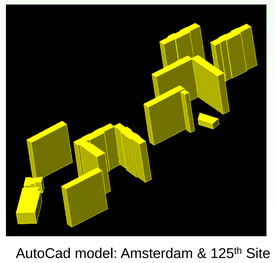
Further wind studies have determined relative levels of wind turbine applicability on a scale of 1 (lowest) to 7 (highest). A level of 3 is attributed to those sites where the wind conditions favor the implementation of wind turbine technology. As shown in the diagram to the right, portions of southeast New York vary from 2 to 4 in wind level class. However, these levels are an extremely conservative estimate, as they do not account for localized conditions that increase the efficiency of implementing a wind turbine system; these include the high elevations of the structures at the intersection and the high elevation of the Viaducts. To account for these height variations, a vertical adjustment was made to the wind speed using the equation[2]:



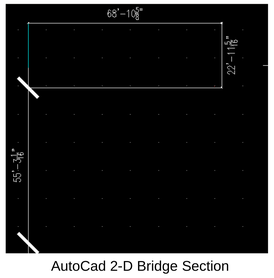
Wind Power Classes, Southeast New York

$$\frac{\bar{V}_r}{\bar{V}_a} = \left(\frac{Z_r}{Z_a}\right)^{\alpha} \quad or \quad \frac{\bar{P}_r}{\bar{P}_a} = \left(\frac{Z_r}{Z_a}\right)^{3\alpha}$$

Where V_r and V_a are the velocities at the new height and initial height, and Z_r and Z_a are the new height and initial height, respectively. The exponent in the equation is a power law exponent that is empirically derived. The velocities tabulated above are found through a weighted average of the heights of each structure in the site. Such a method allows a fairly accurate analysis without inputting a complicated wind function into the modeling software.



AutoCad model: Amsterdam & 125th Site



AutoCad 2-D Bridge Section

In order to reduce the complexity of the ornately designed Viaducts and allow a finite element analysis, only the critical variables defining the bridge were used in the design of the model. These variables were the overall height, thickness, width, and local length of nonporous media, such as a solid plane surface along the side of the bridge. The site at Amsterdam and 125th was reduced to the housing projects buildings. All non-high rise buildings found beyond a short proximity of the main housing projects were eliminated because they would not significantly shift wind direction or alter wind speeds. However, as shown in the snapshot here, there were a number of buildings that could not be eliminated before the analysis because their contributions were not trivial. Consider the relative complexity of modeling each of the sites. Since the Viaducts had unobstructed exposure to the oncoming winds, even the 2-D model shown below would have been sufficient for the design (although a 3-D model was chosen for greater accuracy). But the buildings at the second site were layered and thus significantly altered local wind conditions. Consequently, the model could not be simplified beyond what is shown in the image aside.

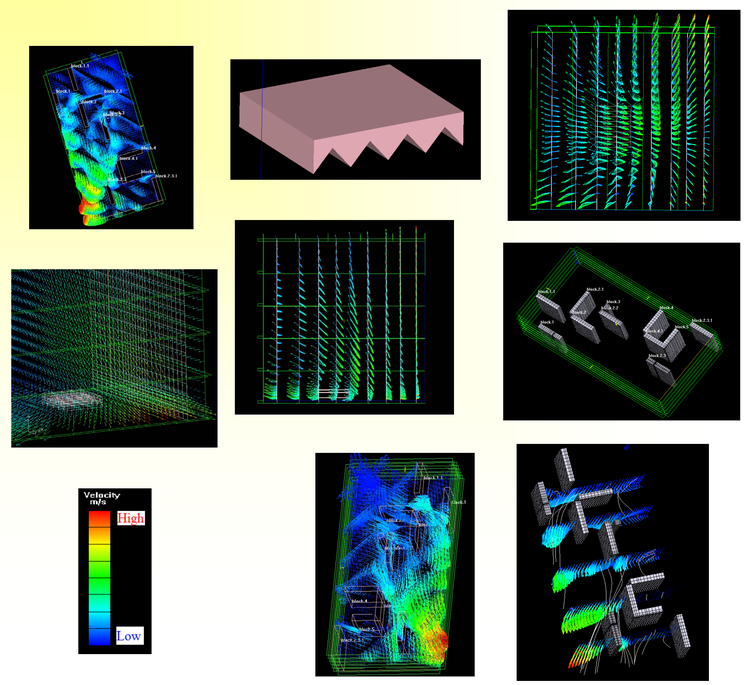
Further Design Assumptions:

The major limitation of Airpak is that it is primarily designed for analyzing indoor air flow. In order to simulate the outdoors, the models were placed in a relatively large room (on the order of 100 times the size of the model). Furthermore, the outer faces of the room were assumed to be air vents to allow exit air flow, except of course in the primary wind directions and floor face.

The wind flow analysis program, *Airpak*, was set to do calculations with turbulent flow (Reynolds number, R_e >> 2000), which is an essential consideration when analyzing complicated wind flow. It is also assumed that the temperature at the site is 13 degrees Celsius, as this is the mean annual temperature of New York City. This may be of some significance because temperature is inversely related to air density. With greater air density, it is possible to generate more energy through windmills (see *Possible Energy Generation*).

Results of Analysis:

Using the Navier-Stokes equations for the conservation of energy and momemtum, Fluent outputted the following wind flow results:



Wind Vector Fields in Bridge Model; Red is highest velocity, blue (10.5 mph) is lowest

Possible Energy Generation:

In the following empirically derived equation, ρ is the air density (in kg/m³) at 13 degrees Celsius and V is the wind velocity (in m/s). Of course, if the wind turbines are tactically placed throughout the site in areas that maximize wind velocity, it will be possible to harness even more energy[2].

$$\bar{P} = 0.955\,\bar{\rho}\,\overline{V^3}$$

The wind power density (P) equation above demonstrates that even with no magnification of wind speed, it is possible to harness approximately **193 W/m²** of energy through a face taken perpendicular to the wind direction. The degree to which this potential is developed is dependent on the type of wind turbines used, and the ability to construct them so as to maximize their perpendicular orientation to varying winds. One possibility would be to link the turbines to weather stations that provide continuously updated wind direction information. In such a way, the wind turbines could be equipped with a rotating device that would calibrate the angle of the face to match the wind direction.

The amount of energy that can be generated with different size turbines is summarized in the following table:

Wind Power Density (W/m²)	Wind Turbine Radius (m)	Energy (W)	Annual Energy (KW-hrs)
193	1	606	5,311
193	2	2,425	21,246
193	3	5,457	47,803

As New York City dives into the future world of rapidly expanding energy demand and marginally lower energy supply, it would be prudent to develop systems that ensure a continued delivery of energy. Numerous countries worldwide, including Germany, Spain, and India have already taken advantage of this energy source with heavy expansion plans for the future. Harlem has an opportunity to set the benchmark for New York City in harnessing alternate energy sources, and become vanguard in the implementation of wind energy systems.

References: 1: http://www.nynjcoast.org/nycdepharbor_survey/Data_query/data_form.asp 2. http://rredc.nrel.gov/wind/pubs/atlas/appendix_A.html 3. http://www.ewea.org/documents/ewea.pdf 4. http://www.unc.edu/~rowlett/units/dictW.html 5. http://en.wikipedia.org/wiki/Wind_turbine 6. http://en.wikipedia.org/wiki/Wind_power#Economics

Urban Ecology Studio: 125th Street Smart Street Proposals

SUPERBLOCK: Green Solutions

Civil Engineering Student: Sevinc Yuksel **Architecture Student:** Samina Iqbal **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

Current Green Problem:

The following provide reasons for why green roofs should be considered in New York City:

•Urban heat island effect:Parking lots, dark roofs and asphalt can combine to raise temperatures anywhere from 2 to 10 degrees. The hot air helps create ozone, a component of smog.

•Combined Sewer overflow problem: About half the time it rains in New York City, raw sewage and polluted runoff combine in sewer pipes and overflow – without treatment – into the City's surface waters. 460 CSO pipes throughout the five boroughs dump 27 billion gallons of untreated wastewater into NYC's waterways each year. CSO events occur somewhere in NYC over 70 times each year – an average of at least one overflow each week. In some areas, 1/10 inch of rain in an hour can trigger a CSO event.

•Air quality: urban infrastructure, waste, heavy traffic pollution

Green Roof Site Specifications:

For this specific project the following apply:

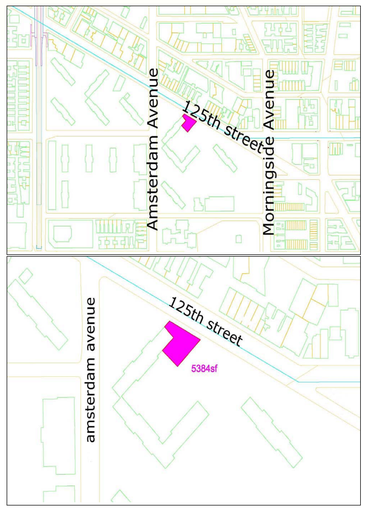
•Superblock location: between Amsterdam and Morningside avenue/ south of 125 street

•Green roof location: Amsterdam Avenue and 125th street corner. Located on the outer side of the Superblock.

•2-3 story high newly constructed building. (flexible with loading conditions)

•20 story towers are located behind the green building causing significant shade conditions.

•Water treatment system in the superblock, which could be integrated to the green system.



Green Roof Loading Analysis:

The following loading conditions should be considered for the green roof:

•A Green roof with 8 inch soil depth would have a dry assembly weight of 50 LB/SF. The wet weight (the saturated weight) would be approximately 78LB/SF. One inch of water weighs 5.2 LB. The difference between the two is 28 LB, so the equivalent of over 5 inches of rain would have to fall to saturate an assemble of 8 inch soil depth.

•Superblock green roof assembly will have soil depths ranging from 4 inches to 16 inches. Therefore the saturated weight will vary from 39LB/SF to 156LB/SF. Previous case studies show that a 16inch concrete slab for the roof assemble will be enough to support to green loading.

Green Roof Design:

(cross section)

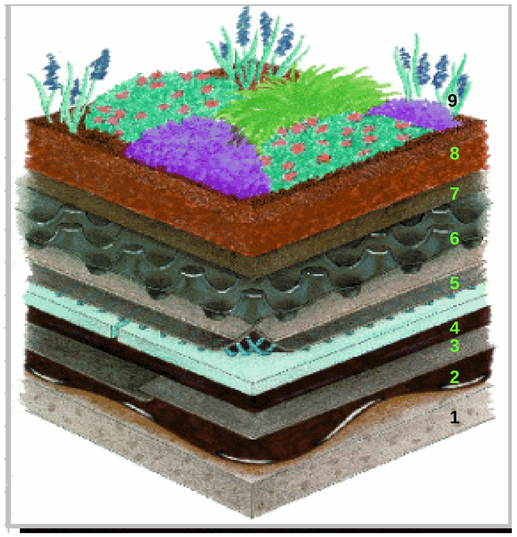
Description of layers from concrete rooftop to vegetation:

1-Roof deck: 16inch concrete slab roof deck.

2-Roofing Membrane: Monolithic Membrane is hot, fluid applied, rubberized asphalt, which serves as a waterproofing membrane. It is applied in two coats, with a layer of fabric reinforcement between layers, to a thickness of 215mils.

3-Protection Course/Root Barrier: Prevents roots from penetrating the roofing membrane. Hydroflex RB is a heavy-duty protection course used for roofs, which will be subject to high amounts of construction traffic or where plants with deeper and more aggressive root structures are to be planted.

4-Insulation/Air barrier: Dow STYROFOAM is a closed cell, extruded polystyrene that exhibits high compressive strength and moisture resistance, while maintaining excellent long term insulation value.



5-Water retention: Additional water retention can be achieved through the use of Moisture Retention Mat SSM45, which is composed of non-rotting, polypropylene fibers stitched through a polyethylene carrier sheet that is rolled out over the root barrier or insulation/air layer.

6-Drainage/Water Storage/Aeration: Floradrain FD60 provides superior water drainage, water storage, and aeration to create a harmonious balance of air and water in the substrate soil. It is specifically designed for intensive systems where substantial water retention is required for plant usage. FD60 consists of lightweight panels of 100% recycled polyethylene, molded into specially designed drainage channels and retention cups filled with mineral soil. The unique design allows for the free drainage of excess water, achieving flow rates from 2.5 to 28 times higher than that of conventional drainage methods. At the same time, the system is engineered to promote irrigation through capillary action and evaporation into the soil/vegetation level. Floradrain is installed loose-laid over the Moisture Retention Mat SSM45 or insulation. It is easily cut to fit around penetrations, perimeters, and drains.

7-Filter Fabric: Systemfilter SF is a geotextile filter sheet made of non-rotting, non-woven polypropylene fibers. It is highly resistant to all natural acids and alkalis, and chemically neutral. Systemfilter SF is unrolled over the entire roof area completely covering the Floradrain elements.

8-Soils: The choice of soil is very critical for the greenroof system. The soil needs to provide a stable structure for the anchorage of the plants' root system, while remaining as light as possible to prevent excess loading of the roof structure. It must also supply essential nutrients, water and oxygen.

9-Vegetation: The selection of the appropriate plants depends on the building construction, anticipated use of roof, soil depth and climate conditions. Variety of choices is available for intensive roofscapes, including sod grass lawns, perennial flowers, shrubs and even small trees. (information obtained from reference#3)

▪Irrigation: A pipe is placed in 20 inches spacing along the soil layer. The moisture of the soil is measured constantly and when its below the required water content, irrigation is activated. In the Superblock green roof design recycled water coming from the water treatment system will be incorporated to the irrigation system.

Plant Selection:

Harlem is located in the Hydration zone 7. Preferable green roof plants are as follows:

name	flower cl.	bloom time	h zone	shade tol	origin
Delosperma nubigenum	yellow	may-june	6	high	
Talinum calycinum	rose pink	june-oct	6	no	native
Sedum lanceolatum	yellow	july	6	no	native
talinum parvifolium	pink	june-july	6	no	native
talinum rugosperum	rose pink	june-july	6	no	native
Sedum oreganum	yellow	july-aug	5	yes	native


Delosperma nubigenum

We could also consider endangered plants of New York State to bring the species back to life:

name:	Fed. Status	ST.Status
Agalinis acuta	Endangered	S1
Isotria Medeoloides	Endangered	SH
Schwalbea americana	Endangered	SX
Scirpus ancistrochaetus	Endangered	SX


Talinum calycinum


Isotria medeoloides

S1: Critically imperiled in New York State due to extreme rarity.
SH: Historical. No existing sites known in New York in the last 20 years.
SX: Extirpated from New York State.

Green Objectives:

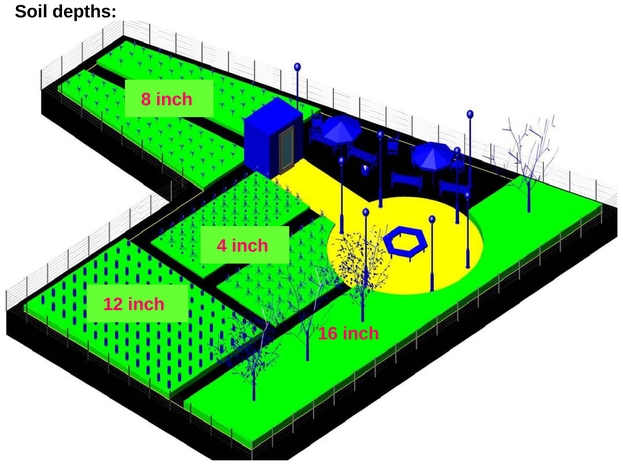
The objectives of the superblock green roof are as follows:

•Improve air quality: cleanses the airborne toxins, re-oxygenates the air
•Reduce temperature extremes (significant solution for Urban Heat Island Effect)
•Increase roof life time (20years vs. 40 years)
•Reduce storm water runoff (significant solution for CSO problem)
•Prevent mechanical damage to the roof
•Reduce noise transmission into the building
•Increase energy efficiency
•Create additional usable space for tenants
•Increase property value
•Create therapeutic and peaceful environments
•Create potential government enticements

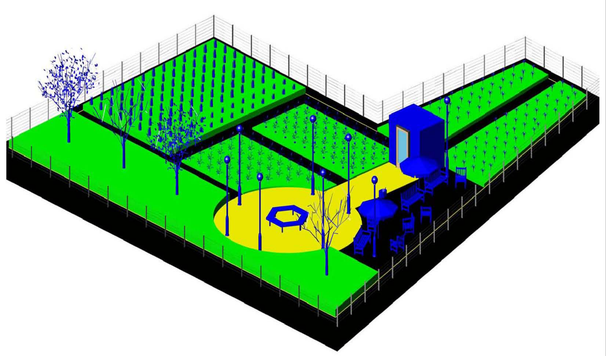
Green Facts:

•A 20000sf green roof saves the city $10000 in annual energy cost.
•Usually 1.5 times more expensive to have a green roof.
•Chicago is considering reducing drainage fees of building with green roofs by 35%.
•Natural landscapes of vegetation and soil have the ability through evapotranspiration (the loss of water from the soil both by evaporation and transpiration from the plants growing thereon) to reduce the heating potential of incoming solar radiation.
•Green roof components can retain between 50% - 90% (in our case 75-80%) of a typical rain that falls on the roof surface. This retained water is then available for use by the vegetation instead of being added to the storm drains. In addition, the run-off that does occur is obviously slowed by having to percolate through the Garden Roof system. This slowing of the run-off also aids the storm drain network by reducing the intensity of the wave that travels through the network.
•90% of solar energy is absorbed by the green roof
•10sf of leaf surface removes 5lb of particulates annually, which fights air pollution.

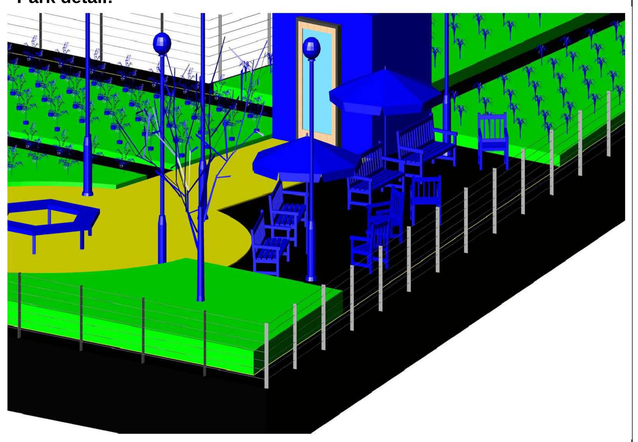
Soil depths:



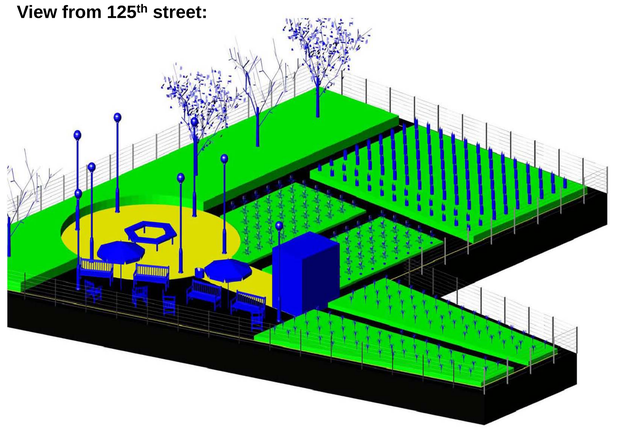
Rooftop design:



Park detail:



View from 125th street:



References: 1. http://www.theslatinreport.com/top_story.jsp?StoryName=0304gr.txt&Topic=Design&fromPage=Design 2. http://www.riverkeeper.org/document.php/329/Riverkeepers_CS.doc 3. http://www.hydrotechusa.com/START.HTM 4. www.greenroofplants.com 5. http://www.dec.state.ny.us/website/dfwmr/heritage/rpsl.pdf 6. http://www.thegardenhelper.com/ps~trees.html?

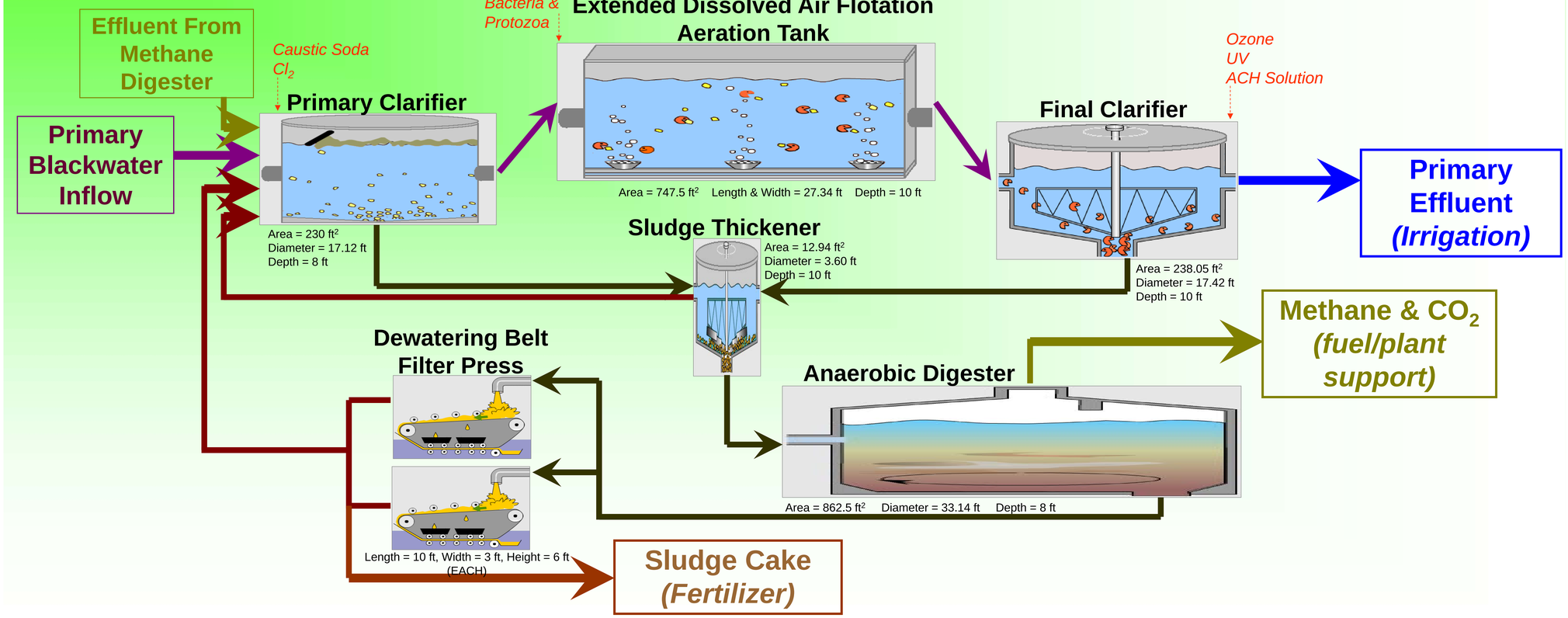
7. http://permanent.access.gpo.gov/websites/epagov/www.epa.gov/OWOW/nps/roofcover.pdf 8. www.balmori.com 9. http://www.greenroofs.org/pages/grhc2004_solaire_bldg.htm 10. Information provided by Tom Chartier and Stuart Gaffin

Urban Ecology Studio: 125th Street Smart Street Proposals

WASTEWATER TREATMENT

Civil Engineering Student: Suzanna Silverstein **Architecture Student/s:** Samina Iqbal & Jared Olmsted **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

Schematic Diagram of Designed Wastewater Treatment Process



*Measurements in black are design values for Samina Iqbal's project. The image is approximately to scale.

Project Applications

Jared Olmsted

- Waste water and restaurant food waste will be used to harvest methane and CO_2 gas.
- Goals:
  - Methane for operating vehicles, heating buildings, and (once converted to electricity) powering street lights and more.
  - $C0_2$ and recycled water for sustaining plant life in urban farm/eco tower
  - Recycled water for irrigation of green roofs, urban farms/eco towers, and landscaping.

Samina Iqbal

- Population (per Facility): 1150
- Convert waste from housing towers to generative component for site.
- 3 Treatment facilities will handle 2/3 of current housing's blackwater.
- Goals:
  - Recycled water for irrigation of green roofs and urban farms.
  - Sludge for fertilizer.
  - Methane for energy.
  - Employment opportunities in facilities.

Cost Issues

(Comparison to the ***Solaire***)

- **Equipment:** Setting up a custom treatment center with large industrial equipment has a tremendous initial cost. Should any of the equipment need to be replaced, the impact of these costs will be compounded.

- **Labor:** The Solaire treats about 30,000 gallons per day (substantially less than Smart Streets scenarios) and has a staff of 25. In addition to paying wages, employee training for operation and maintenance of the facility will be needed. An engineer should also be on call or on staff to conduct pilot tests and adjust chemical dosages.

+ **Government Credits:** The government offers financial rewards for environmentally friendly buildings. The *Solaire* has received a LEED Gold rating and has proven a 25% reduction in their contribution to the city sewer system. They state that the tax and utility breaks they receive for these accomplishments more than compensates for the additional costs they have incurred by having their own blackwater treatment.

Design Standards

(From the ***Solaire***)

BOD < 10 mg/L

Suspended Solids < 10 mg/L

Fecal Colliform < 100/100mL

pH 6.5 - 8

Total Dissolved Solids 250 - 450 mg/L

Turbidity < 0.5 NTU

(**NTU** = Nephelometric Turbidity Units)

Design Process

A spreadsheet was created to assist with the design processes. The following table lists the inputs and outputs for the spreadsheet calculations.

	Inputs	Outputs
Influent MakeUp	Population	Flow Rate
		BOD
		SS
		VS
		TDS
Primary Clarifier	Flow Rate (Q)	Area
	Depth	Volume
	Bottom Slope	Detention Time
	Overflow Rate	Weir Loading
		BOD & SS Removal
Aeration Tank	BOD	MLSS
	F/M	Recirculation (R)
	R/Q	Combined Influent (Q+R)
	Depth	Area
	BOD Design Load	
Final Clarifier	Depth	Area
	Bottom Slope	Detention Time
	Overflow Rate	Weir Loading
	Flow (Q+R)	BOD, SS, & VS Removal
Thickener	SS	Area
	Depth	Volume
	Area Design Load	SS Removal
Anaerobic Digester	Depth	Volume
	Population	Area
	Volume Loading (per capita)	Gas Production
	VS_{in}	Methane Production
	$VS_{out\ (70\%\ removal)}$	CO_2 Productions
	Gas Production/VS	
	Gas Composition %s	
Dewatering	Operating Time	Belt Width
	Total Dissolved Solids	Manufacturer Standards
	Solids Load Design	Equipment Dimensions
	Quantity (2)	
Effluent	Population	Water Flow
	Treatment Standards	Sludge Supply
		CO_2 Supply
		Methane Supply
Storage	Building Height	Necessary Capacity
	Usage Patterns	Dimensions
	Flow Rates	

References: **1:** The Water Environment Federation www.wef.org **2:** Water and Wastewater Technology, Hammer & Hammer, Englewood Cliffs NJ, Prentice Hall 1996 **3:** Water Treatment: Principles and Design, MWH, Hoboken NJ, John Wiley & Sons 2005 **4:** Unit Operations & Processes in Environmental Engineering, "Activated Sludge", Reynolds & Richards, Thomas Engineering 1995 **5:** Professor William Becker, Columbia University, November 2005 (Conversations) **6:** Koch Water www.koch_water.com **7:** Tom Chartier from the Solaire **8:** Mike Svavoda, Applied Water Management (Solaire WWTP Design Engineer)

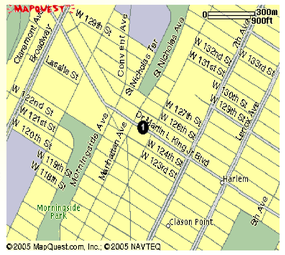
Urban Ecology Studio: 125th Street Smart Street Proposals

VERTICAL FARMING

Civil Engineering Student: Leonardo Nahas **Architecture Student/s:** Samina Iqbal **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

Site Description [1]

Rich in history, famous for its cultural institutions, recognized for its arts, and respected for its many great leaders, Harlem is well known as a diverse community of African-Americans, Caribbeans, Latinos, and Africans. It is internationally known for its literature, music, dance, sports, and the arts. 125th Street located in the heart of Harlem, in the city of New York, is a street that is rich in the latter description that make this Street an integral part of Manhattan. 125th street mostly comprehends of small businesses and fast food places that are looking forward to grow and give the community history written in their own words, culture, food, tradition.



Site History [2]

In the year 1658 Dutch Governor Peter Stuyvesant established Nieuw Harrlem. In 1683, Harlem was considered a part of New York City and County, even though it remained a sparsely rural district. Through time, Harlem started to grow and develop. Soon it became a very important district that made an important relevance in history.

Why Vertical Farming? [3]

A wonderful explanation to answer this question comes from the words of Dr. Dickson Despommier, who is deeply involved in the process of evolving the vertical farming process. “Over the next 50 years, the human population is expected to rise to at least 8.6 billion, requiring an additional 109 hectares to feed them using current technologies. That quantity of farmland is no longer available. Thus, alternative strategies for obtaining an abundant and varied food supply without encroachment into the few remaining functional ecosystems must be seriously entertained. If traditional farming could be replaced by constructing urban food production centers - vertical farms - then a long-term benefit would be the gradual repair of many of the world’s damaged ecosystems through the systematic abandonment of farmland. Social benefits of vertical farming include the creation of a sustainable urban environment that encourages good health for all who choose to live there; new employment opportunities; fewer abandoned lots and buildings; cleaner air; and an abundant supply of safe drinking water.”

Method to be used: *Aeroponics.* [4]

Aeroponics is the most recent development in hydroponic methods, and one that has gained much publicity over recent years. It is defined by the International Society for Soiless Culture as a system where roots are continuously or discontinuously in an environment saturated with fine drops (a mist or aerosol) of nutrient solution." The method requires no substrate and entails growing plants with their roots suspended in a deep air or growth chamber, with the roots periodically atomized with a fine mist of nutrients.

The Advantages:

There are several benefits to aeroponics, such as maximum oxygen exposure to the root system, the ability to cool the nutrient solution to counteract excessively warm temperatures, and the ability to selectively harvest some root crops, such as potatoes, without having to dig up the soil or growing medium

The Disadvantages:

Apart from the relatively high set up costs, the technique is mechanically quite elaborate, susceptible to malfunction, requires precise regulation and control of water and nutrients, and has no buffer capacity to sustain even slight deviations or occasional malfunctions. In the event of blocked nozzles or breakdowns going unnoticed, plants may be irreparably damaged in a relatively short time.

Description of Possible Crops to be grown in Harlem: [5]

The vegetables most likely to be grown in Harlem are the most common in the entire city. These are: Lettuce, Tomatoes, Cucumbers, Sweet Potatoes, and Strawberries.

The tomato is the second most widely grown vegetable crop in the world and the number one vegetable grown in home gardens in the U.S. Rich in Vitamins A and C, tomato fruit contains the antioxidant lycopene. A recent long-term medical study indicates that individuals who regularly consume fresh tomatoes or processed tomato products are less likely to develop certain forms of cancer than those who do not. Tomato Plant Culture: In the Field, Greenhouse, and Home Garden provides comprehensive factual information about tomato plant culture and fruit production, beneficial to plant scientists and commercial field and greenhouse growers as well as the home gardener. Data compiled focuses on the more recent literature, including information about the cultural characteristics of the plant; fruit production and related quality factors; and environmental and nutritional requirements for both field- and greenhouse-grown plants.

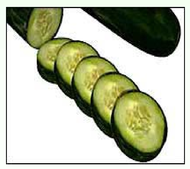
The modern cucumber (*Cucumis sativus*) is probably a descendent of the wild *Cucumis harwickii*, a native of the foothills of the Himalayas. The culinary cucumber was known in India by at least 2000 BC. The Gherkin (*Cucumis anguria*) descends from the African *Cucumis longipes* and was introduced to the West Indies, probably with the Portuguese slave trade, from Angola. It has commonly been called the West Indies Gherkin, due to the mistaken belief, dating to at least the 18th century, that the West Indies was its place of origin. All of the ancient Roman writers on agriculture mention the cucumber. Marcus Terentius Varro (116-27 BC) gives the Latin name of *Curvimur* for the cucumber, referring to the curvature of the fruit. The Greek name for cucumber is *sikys*, meaning the plant has no aphrodisiac qualities, hence the Greek proverb; "Let a woman weaving a cloak eat a cucumber; because female weavers, if we believe Aristotle, are unchaste, and eager for love making." Pliny the Elder (23-79 AD) records the often repeated story of the cucumber being; "a delicacy for which the emperor Tiberius had a remarkable partiality; in fact there was never a day on which he was not supplied with it"

The lettuce can be described as a variety of plants of the genus Lactuca, probably native to the Mediterranean and now grown worldwide; their leaves are generally consumed fresh in salads or used as a garnish. There are three principal types of lettuces: butterhead, crisp head and leaf.

The sweet potato (Ipomoea batatas) is a crop plant whose large, starchy, sweet-tasting tuberous roots are an important root vegetable. The young leaves and shoots are sometimes eaten as greens. The sweet potato is only distantly related to the potato (Solanum tuberosum). Although the sweet potato is sometimes known as yam in the United States, it is unrelated to the botanical yam.

Strawberries are used by some to treat anemia, joint disease, and to strengthen the circulatory system and help balance hormones. They contain high amounts of vitamin C, as well as iron, which needs vitamin C to be absorbed efficiently. Vitamin C is an antioxidant. Strawberries are high in pectin, a soluble fiber that may lower cholesterol. Strawberries were traditionally used in European medicine to eliminate kidney stones.

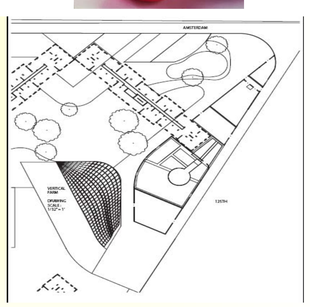




Location of the Possible Vertical Farm: [6]

Using the site history and historical maps, the expected location for the Vertical Farm to be built was determined to be in the center block of Amsterdam with 125th street and 123rd street.

For space availability, this is indeed, the best possible spot for it to be built, the main reason is because it has a great amount of natural light.



Calculations of Energy and amount of Produce:

Brief Energy Requirements for Vertical Farm crops

Plants	50K	per week	area/patch(ft2)	Watts/ft 2	Watts / week	Watts / year	kWh -yearly
Tomato	1964404	37777	7555	8.3	105352497	5478329875	5500000
Eggplant	**6591**	**1269**	**2855**	**2.32**	**6676588**	**34182617**	**34183**
Peppers	369255	7101	7101	2.32	11532010	599664520	599665
Soy Beans	**2155**	**415**	**3237**	**2.32**	**7570413**	**393661497**	**393661**
Green Peas	22375	430	3372	2.32	12952256	569517312	569517
Spinach	**2102400**	**4044307**	**117190**	**2.32**	**1141189936**	**5937876672**	**5900000**
Carrots	9733348	187179	11698	2.32	30396083	1580596326	1600000
Cucumbers	**20250**	**389**	**1558**	**15.77**	**31295565**	**1627369380**	**1600000**
Wheat	20300751	390399	32533	2.32	76080957	3956209770	4000000
Lettuce	**6078788**	**116899**	**33022**	**2.5**	**41607720**	**2163601440**	**2200000**
Strawberries	1164615	22396	22396	7.06	478142058	2.48634E+11	2400000
TOTAL					1942796083		24797026

Avg Produce Intake	322	kg/person
People in NYC	9.00E+06	
1 Ha =	26759	kg

Land Use for Production in NYC (Ha)

108300.01

Ecol. footprint / pers	3.2	acres
People in NYC	9.00E+06	
1 Ha =	26759	kg

Ecological Footprint (acres = ac)

28800000.00

Total U.S. land area	962909000	Ha
Total NYC land req.	2.88E+07	ac
1 Ha =	26759	kg
Total NYC land req.	1.17E+07	Ha
Percentage	1.21E+00	%

Number of people Consuming Vertical Farming in the United States

Plant	Avg. Daily U.S. Consumption	Vertical Farm Daily Yield	Number of people Fed per crop
Lettuce	16	25616	1601
Cucumbers	**3**	**34701**	**11567**
Tomatoes	12	31089	2591
Sweet Potatoes	**3.6**	**44679**	**12411**
Strawberries	3	12415	4138

Crop Name	Minimum Lbs/100sf	Space Available (sf)	Total Produce (lbs)
Lettuce	688	5000	34400
Cucumbers	932	5000	46600
Tomatoes	835	5000	41750
Sweet Potatoes	1200	5000	60000
Strawberries	333	5000	16650

Potential Advantages/Disadvantages of Vertical Farming: [3]

Advantages:

- *Year-round crop production*
- *Eliminates agricultural runoff (worlds’ greatest source of pollution)*
- *Dramatically reduces use of fossil fuels*
- *Makes use of abandoned or unused properties*
- *No weather related crop failures (drought, flood, etc.)*
- *Sustainability for urban centers*
- *Converts black water to potable water*
- *Adds energy back to the grid via methane generation*
- *Offers new employment opportunities*
- *Could dramatically reduce incidence of some tropical infectious diseases*
- *Returns farm land to nature, restoring ecosystem services*

Disadvantages:

- *Diversity of plants limited, as is the market for products.*
- *Initially will not be cost effective.*
- *Integration and acceptance of vertical farming into society may be difficult.*
- *The public will have health concerns about use of blackwater.*

Proposed Vertical Farming:

The vertical farm that we are proposing for the improvement of crops in the Harlem area is simply a building of 12 stories high, of which each floor will treat a crop individually for the cultivation of high amounts of vegetables.

As shown in this poster, the vegetables that are being proposed are:
Cucumber – Lettuce – Tomato - Sweet Potato – Strawberry.

One of the main reasons for this Vertical Farm is that it will be the pioneer one in the city of New York, and the location of Harlem will create such a great attention that it will increase the tourism, improve the businesses, create more jobs, improve the quality of the foos that will go to the restaurants, supermarkets, grocery stores, etc.

References: 1. http://125thstreetbid.com/ 2. Carolyn Matsumoto. Harlem History. GSAPP student. Columbia University, 2005. 3. http://www.verticalfarm.com. Dr. Dickson Despommier. 4. http://www.growingedge.com/community/archive/read.php3?c=GS&q=1149 and http://www.hydroponics.com.au/back_issues/issue05.html
5. Cucumbers: http://www.history.org/history/CWLand/resrch6.cfm Tomatoes: http://www.floridaplants.com/CR/nov1.htm Lettuce: www.cooksrecipes.com/cooking-dictionary/L-search-results.html Sweet Potato: en.wikipedia.org/wiki/Sweet_potato Strawberries: www.nakedjuice.com/iwant_glossary.php

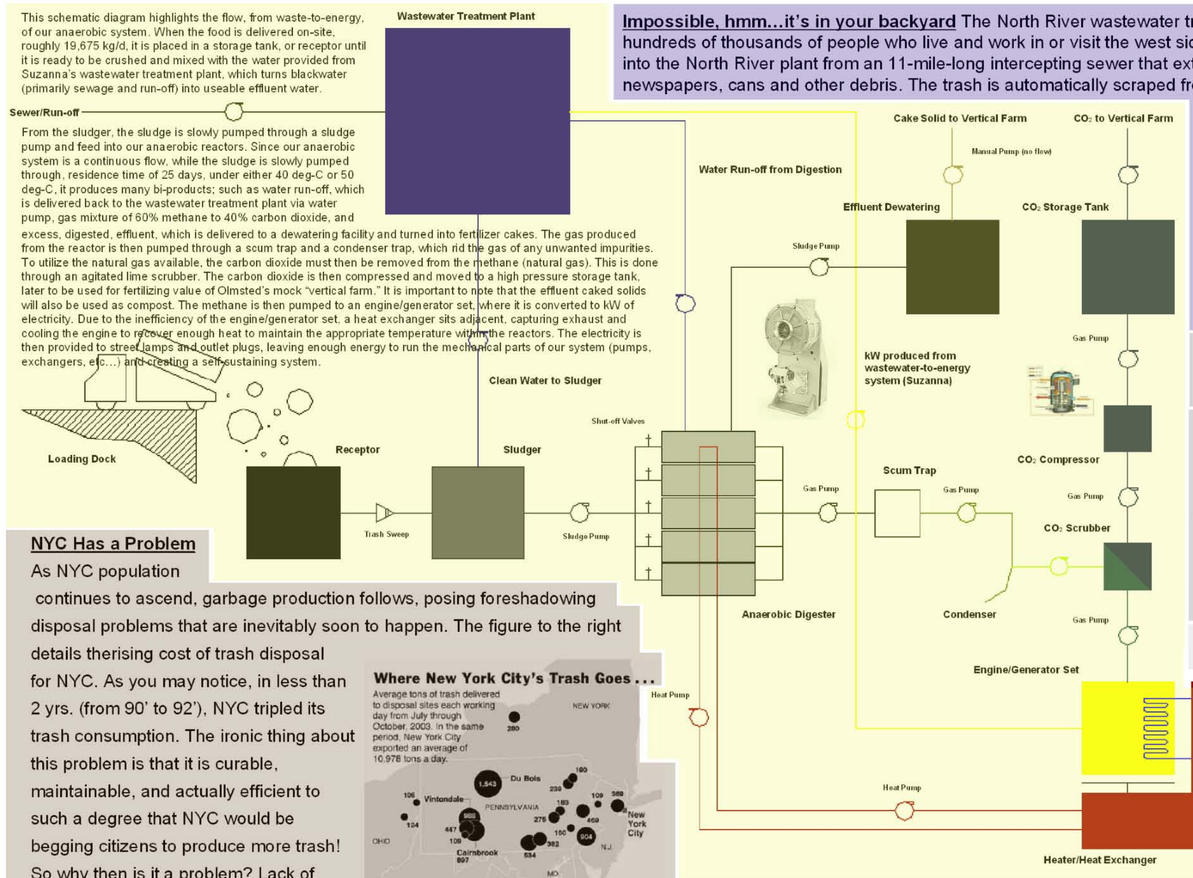
Urban Ecology Studio: 125th Street Smart Street Proposals

Anaerobic Waste-to-Energy System

Civil Engineering Student: Kipp C. Edick **Architecture Student/s:** Jared Olmsted **Studio Critics:** Patricia J. Culligan (Engineering), Richard A. Plunz (Architect)

This schematic diagram highlights the flow, from waste-to-energy, of our anaerobic system. When the food is delivered on-site, roughly 19,675 kg/d, it is placed in a storage tank, or receptor until it is ready to be crushed and mixed with the water provided from Suzanna's wastewater treatment plant, which turns blackwater (primarily sewage and run-off) into useable effluent water.

From the sludger, the sludge is slowly pumped through a sludge pump and feed into our anaerobic reactors. Since our anaerobic system is a continuous flow, while the sludge is slowly pumped through, residence time of 25 days, under either 40 deg-C or 50 deg-C, it produces many bi-products; such as water run-off, which is delivered back to the wastewater treatment plant via water pump, gas mixture of 60% methane to 40% carbon dioxide, and excess, digested, effluent, which is delivered to a dewatering facility and turned into fertilizer cakes. The gas produced from the reactor is then pumped through a scum trap and a condenser trap, which rid the gas of any unwanted impurities. To utilize the natural gas available, the carbon dioxide must then be removed from the methane (natural gas). This is done through an agitated lime scrubber. The carbon dioxide is then compressed and moved to a high pressure storage tank, later to be used for fertilizing value of Olmsted's mock "vertical farm." It is important to note that the effluent caked solids will also be used as compost. The methane is then pumped to an engine/generator set, where it is converted to kW of electricity. Due to the inefficiency of the engine/generator set, a heat exchanger sits adjacent, capturing exhaust and cooling the engine to recover enough heat to maintain the appropriate temperature within the reactors. The electricity is then provided to street lamps and outlet plugs, leaving enough energy to run the mechanical parts of our system (pumps, exchangers, etc…) and creating a self-sustaining system.

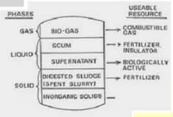


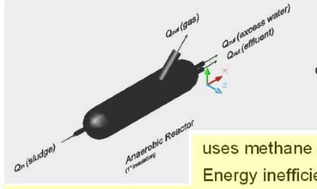
Impossible, hmm…it's in your backyard The North River wastewater treatment plant is located on the Hudson River, west of the West Side Highway from 137th Street to 145th Street. The plant provides wastewater treatment for the hundreds of thousands of people who live and work in or visit the west side of Manhattan, from Bank Street in Greenwich Village to Inwood Hill at the island's northern tip. How does it operate? Several stories underground, wastewater flows into the North River plant from an 11-mile-long intercepting sewer that extends along Manhattan's west side. Upon entering the plant, the wastewater first passes through upright bars that remove large items, including rags, sticks, newspapers, cans and other debris. The trash is automatically scraped from the bars and later transported to a landfill. Five main sewage pumps lift the wastewater to the surface level primary settling tanks. The flow of the water is slowed, allowing the heavier solids to settle on the bottom and the lighter materials to float. Oil and grease are skimmed from the top of the tanks and the heavy solids, called "primary sludge," are scraped off the bottom for further processing. The partially-treated wastewater then flows to the secondary treatment system. Secondary treatment is called the "activated sludge process," because air and "seed" sludge from the plant treatment process are added to the wastewater to break it down further. Air pumped into five, 30-foot-deep aeration tanks stimulates the growth of oxygen-using bacteria and other tiny organisms that consume most of the remaining organic materials that pollute the water. The aerated wastewater then flows to 16 final settling tanks, where heavy particles and other solids again settle to the bottom. Some of this sludge is recirculated back to the aeration tanks as "seed" to stimulate the treatment process. The remaining solids are removed and join the primary sludge for further processing in sludge-handling facilities. To destroy disease-causing organisms, the wastewater is disinfected with sodium hypochlorite, the same chemical found in common household chlorine bleach. The treated wastewater, called effluent, is then released into the Hudson River. (Suzanna's project incorporates all aspects of the waste-water to clean water, plus waste-water to energy, system)

Sludger To accurately mimic stomach digestion, the sludger needs to crush and mix the correct amount of food waste to water ratio, or pH ratio. A typical waste to energy plant will try to optimize a pH value between 7–7.5. In direct consequence, our carbon to nitrogen, C-N, ratio must be 30:1. That is, food is 40:1, raw sewage is 16:1, and therefore, the food to water ratio is 1:1.4. This creates a well balanced solution optimal for producing contained gas emissions.

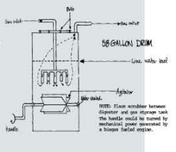
Sludge Pump It is important to recognize that there are two types of anaerobic digestion systems, continuous and non-continuous. We designed our system according to the the continuous flow system because it allows for both constant in-out and allows for mid-span correction barring any pH change. Because we are using a system of 10 reactors (explained next), the flow rate for each is 5.49 m^3/d, which is significantly low. The pump we used for the design is the 520 S/R, which combines adequately small flow rates with superior cleanliness, hygenics, accuracy, and reliability

Anaerobic Reactor The reactor scaling was determined by adding 75% volume to the amount of L of sludge produced daily. Based up C:N and pH ratios, the size of the tank needs to be 75% gaseous void and 25% sludge. It is important to note that in a continuously digesting system, the sludge stratifies within the tank, which explains the design (See the layered drawing to the right)

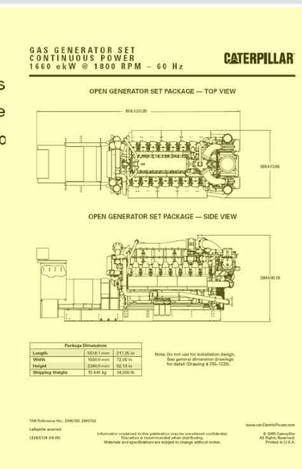




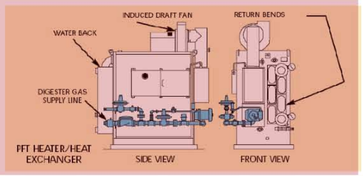
CO_2 Scrubber Since the CO_2 needs to be removed from methane to be able to produce power, this ads some lime to the gas mixture and agitates the separation. Post-process, CO_2 and methane can be harvested individually



Engine/Generator Set After the natural gas has been separated from the CO_2, it can be turned into power via an engine/generator set, which uses methane as fuel. The major downside to the engine/generator set is that they are highly Energy inefficient, producing nearly only 38% of the methane Btu potential. Fortunately, with the application of a heater/heat exchanger, up to 40% of this lost energy can be cultivated and re-used by the system. The engine/generator used for the scaling of this design is the Catepillar engineered 1600 eKW @ 1800 RPM. To operate at the potential outlined in the chart below, nearly 10 of these set would be needed at this scale.



Heater/Heat Exchanger Since our engine/generator set, is only 38% energy efficient, it needs to be coupled with heater/heat exchanger. Heat reclaimed from engine cooling water and exhaust gases can satisfy the digester heat requirements. Of the energy expended to generate power, 28% can be reclaimed as heat from engine cooling water with an additional 12% available through gasreclamation. Hence, the recoverable energy is 2,148 Kw-hr and 2,547 Kw-hr, respectively. It is important to note that early developments of waste solids heating systems employed heating coils within the digester with hot water circulating through the coils. However, these heating systems were subject to a number of problems, such as solids caking, broken pipes, corrosion, etc. Hence, we are using the heater/heat exchanger system in an effort to improve efficiency and limit those potential problems. The product we decided to utilize is the PFT 750,000 Btu heater/heat exchanger, which adequately provide enough energy to heat the entire system (potentially even the building). The images are depicted on the above.



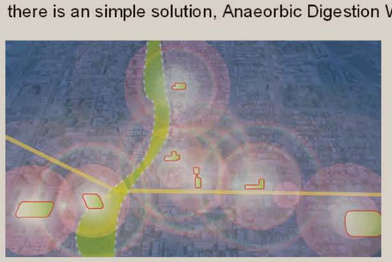
NYC Has a Problem

As NYC population continues to ascend, garbage production follows, posing foreshadowing disposal problems that are inevitably soon to happen. The figure to the right details therising cost of trash disposal for NYC. As you may notice, in less than 2 yrs. (from 90' to 92'), NYC tripled its trash consumption. The ironic thing about this problem is that it is curable, maintainable, and actually efficient to such a degree that NYC would be begging citizens to produce more trash! So why then is it a problem? Lack of information? Yes. Primarily, the citizens of NYC, are highly unaware of what happens to their garbage after they throw it into the white plastic bag (with a zip-tie). I'm sure if you asked the average street walker where their Poland Spring bottle found its resting place, they would be stunned to find out that it is in fact Pennsylvania, or Virginia. It is important to note that for the past half decade, this notion of transporting garbage to a place with more land, was in fact a good idea (for the time being). So then why the sudden urge to change the system? Well, as more states become aware of the fact that they are collection sites for the heavily populated NYC, the more backlash they tend to have, stopping both the dumping availability to NYC and taking matters supreme. A recent article in the New York Times, recently opened the eyes of its citizens to the issue, portraying (on the cover) Manhattan encased its own excrement, which is what would happen if barring no solution. Fortunately for Manhattanites, there is an simple solution, Anaeorbic Digestion Waste-to-Energy System.

What is an Anaerobic Digester Waste-to-Energy System In simple terms, an Anaerobic Digestion System is one that can convert discarded food and sewage waste, digest them together like the acids in your stomach, and then create power from its emissions. Hence, the nature behind the process was developed along side the human body. Heated organic material, at either 40 deg-C or 50 deg-C and at a 30:1 C:N ratio, will first turn acid and smell rank, then slowly over about six months turn alkali. The methane bacteria, always present, will take over and decompose it, and gas bubbles will rise to the surface. As you may know, methane is natural gas post-scrubbing and filtering, and can then be used to power a generator (electricity).

Potential Benefits

-reduce trash exportation significantly
-create heat/energy from post waste-water treatment
-create heat/energy from food waste
-produce high value, nutrient rich, fertilizer
-produce CO_2 for the soil
- with some minor car adjustments, the natural gas produced could be used to fuel cars, dumpsters, etc…
-eliminate the trash problem



The Proposal The site indexed alongside the eastern Apollo façade has been a recent topic of debate. Communal grounds? Deal with street vendors? Etc…In conjunction with Jared Olmsted, architect of the design, we have chosen to design this site to promote both community, education, and intelligence. Incorporating aspects of a vertical farm, structured contour parkway, and a over-engineered waste-to-energy system, this design should, at the very least, promote the idea of facing a problem, embracing it, and envisioning the archetype. This has been successfully done. In addition, one main concern Barbara had pointed to early in the design process has 125th streets lack of adequate street lighting, creating both crime and scandal in the area. In an effort to improve upon these unavoidable lighting-to-crime statistics we have decided to provide a series of street lights with the harvested energy from our system. Its hard to avoid the fact that your trash could be the light.

Amount of waste (dumpters/week)	Volume of dumpster (yd^3)	Restuarunt size (ft^2)	Waste ($ft3/day/ft^2$)	Total Restaurant Area (ft^2)	Total Waste (ft^3/day)	Food Waste (kg/day)	Volatile Solids (80% of waste)
12	2	4200	0.022	43782	964.99	19674.36	15739.49

Temp (C)	T_r (d)	kg (1/d)	Go (L gas/g volatile solid)	Go (L gas)	G	L methane (60%)	L carboon dioxide (40%)
40	25	0.043	0.547	8609500.78	4149157.00	2489494.20	1659662.80
50	25	0.03	0.547	8609500.78	4919714.73	2951828.84	1967885.89

# of Reactors	Flow rate of Slurry (m^3/day)	Volume of Slurry in tank (m^3)	Volume of Tank (m^3)	Length of Reactor with a 2m diameter (m)	Length of Reactor with a 3m diameter (m)	Length of Reactor with a 4m diameter (m)	Length of Reactor with a 5m diameter (m)
1	54.87	1371.74	5486.96	1746.55	776.25	436.64	279.45
2	27.43	685.87	2743.48	873.28	388.12	218.32	139.72
4	13.72	342.94	1371.74	436.64	194.06	109.16	69.86
8	6.86	171.47	685.87	218.32	97.03	54.58	34.93
10	5.49	137.17	548.70	174.66	77.62	43.66	27.94
12	4.57	114.31	457.25	145.55	64.69	36.39	23.29

Methane (L/day)	Energy (J/s)	Energy (kW)
2489494.20	5364744.75	5364.74
2951828.84	6361054.49	6361.05

Mass of waste (kg)	Mass of Water needed (kg)	Volume of water needed (m^3)	Volume of water needed (gallons)	Volume of waste (m^3)
19674.36	27544.11	27.54	7277.15	27.33

Note that calculations moderately include the various energy placed back into the system, and the estimation does not include the initial cost of building this system (i.e. money invested to get running) Although these values are not included, if we used the left over energy to provide the fuel for the system itself, we would have an adequate amount, plus.

Qty of Waste to Export (tons/day)	Cost of Trash Export in 2004	Cost (Expense) per ton of trash	Qty of Trash Volume (tons)	Our Savings
10,978	$ 250,000,000	$ 62.39	7899.26	$ 492,844.74

Cost of Electricity in NYC ($/kW-hr)	$/day	$/year
0.184	987.11	$360,296.26
0.184	1170.43	$427,208.42

Total Savings
1.5 million/y

1. L. John Fry, "Methane Digesters For Fuel Gas and Fertilizer" http://www.journeytoforever.org/biofuel_library/MethaneDigesters/MD1.html 2. Peace Corps, The Biogas/Biofertilizer Business Handbook, 1985, http://peacecorpsonline.org/messages/messages/2629/2023122.html 3. Vesiland, P. Arne, Solid Waste Engineering. Brooks Cole Publishing, Pacific Grove California, 2002. 4. Verderflex Caterpillar, "Gas Generator Set" http://ifs.sim.1.net/images/cstmr/PP8HN/LEHE5104%20final.pdf 5. The AgSTAR Program "US Environmental Protection Agency" http://www.epa.gov/agstar/resources/handbook.html 6. USFilter, A Siemens Business "Heater/Heat Exchange" http://www.usfilter.com/en/

Urban Ecology Studio: 125th Street Smart Street Proposals

Legalize It!: “Green“ Vending on 125th Street

Civil Engineering Students: Natalie Bazile, Gabriel A. Calatrava, **Architecture Student:** Vera Galvez, **Studio Critics:** Patricia J. Culligan **(Engineering)**, Richard A. Plunz **(Architect)**

Introduction:

The removal of the 125th Street vendors has been in the works for quite some time. Attempts were made to relocate the vendors by Mayor Ed Koch and Mayor David Dinkins. In 1992, street vendors held a major protest march in New York City. The store owners were so frightened by this that most decided not to open their stores for fear of vandalism and reprisals. In 1994, the 125th Street Business Improvement District worked along with local community boards and the Department of Business Services to prepare the neighborhood for the vendors’ relocation. Massive protesting ensued and, again the store owners decided to keep their stores closed. Many relocation attempts have been made since, but none have led to complete elimination. Through these events, the vendors have become a indispensable element of the 125th Street history. Today these merchants play a major role in the 125th Street identity. The time has come to acknowledge and integrate these small-scale business owners, allowing them to become useful member of the community. This project deals with the legalization of the vendors and the analyses of the services they could provide for general benefit of 125th Street. The main focus will be the redesign of the street vending carts to create bi-functional vehicles whose integrated technologies give back to the community.

Paper Recycling:

Background of Paper Recycling

A typical business office generates 1.5 pounds of waste per employee per day. Financial businesses generate over 2 pounds per employee per day. Of this, only about 0.5 lbs is recyclable paper.

The grades of office paper for recycling range from high grade (computer print-outs, and white or colored ledger including non-glossy, printed or unprinted white, including letterhead, typing, writing and copy machine paper) to low grade (mixed office paper, including office paper, manila folders, white, colored and glossy paper, junk mail, pamphlets, and brochures).

Since the most commonly recycled papers are computer paper, white ledger paper, colored ledger paper and mixed office paper, we will focus on the collecting these for our recycling program. Although, mixing paper grades usually drops the price of all the paper to the price of the lowest grade included in the mix, the cost of pre-sorting would negate the projected savings.

Most office paper recycling dealers require a minimum of 500 to 1,000 pounds of paper per pickup.

Implementation of Vendor Recycling in 125th Street Offices

RECYCLED PAPER GENERATION:

Total tons recyclable paper/month =

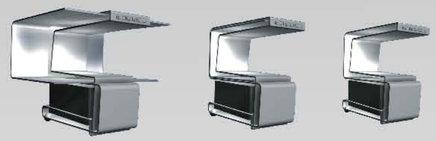
$$\frac{\text{(Recyclable paper/employee/day) x (working days/year)}}{\text{(12 months/year)(2000 lbs/ton)}} = \frac{\text{2700 employees x 0.5 x 240}}{\text{12 x 2000}}$$

$$= \frac{\text{27000 lbs}}{\text{2000 lbs/ton}} = 13.5 \text{ tons/month}$$

POTENTIAL PAPER RECOVERY RATES:

Tons/month recyclable paper recovered =

(Tons recyclable paper/month) x (estimated employee participation rate) = 13.5 x 0.65
= 8.8 tons/month recovered



Recycled Paper Market

The determination of whether savings or profit is made depends on what method of recycling is chosen. One option would be to simply consolidate the recycled paper of various offices, and hire one waste paper management contractor to pick-up, instead of having several contractors serving the multiple offices. This would reduce traffic, and business would save money from discounts given to larger pick-ups. Another option would be to shred and compact the paper on-site. The shredded paper can sold to individuals to re-use in crafts, or as packaging, pet bedding, or mulch. A third option would be to sell the used paper in bulk to companies which use recycled paper to manufacture their own products, such as “green” and “sustainable furniture,” and thermoplastics, which use recycled paper as a reinforcing filler.

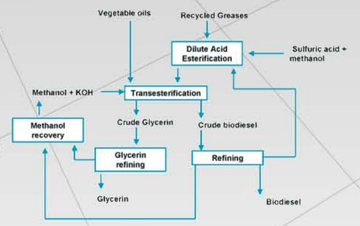
Biodiesel:

Background of Biodiesel Technology

Biodiesel is a clean burning alternative fuel, produced from domestic, renewable resources. It does not contain petroleum, but it can be blended at with conventional petroleum diesel to create a biodiesel blend. It can be used in diesel engines with little or no modifications. It is simple to use, nontoxic, biodegradable, and typically free of nitrogen, sulfur and aromatics.[2]

Biodiesel is produced from any fat or oil, such as vegetable oil, from three basic methods. The most common is a process called transesterification. The oil reacts with alcohol that is added to remove the glycerin, which is a by-product of this refinery process.

The “right” blend, B20 (a blend of 20% biodiesel by volume with 80% petroleum diesel by volume), demonstrates many substantial environmental benefits with the least increase in cost for most consumers. These include reduced emissions of soot, particulates, hydrocarbons, carbon monoxide,



C.Y. biodiesel = 37.8 GJ (33.3 - 35.7 MJ/liter)
1 Cu.f Oil= 0.40 Cu.f Biodiesel

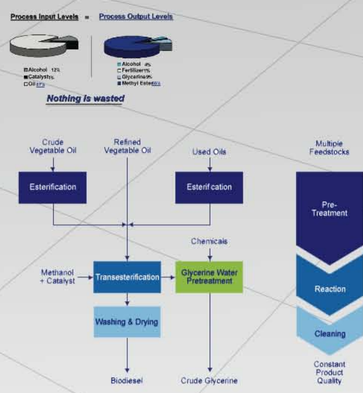
Implementation of Oily Waste Retrieval on 125th Street

There are 23 fast food restaurants along 125th Street, from Fifth Avenue to the Hudson River. Of these, 17 restaurants would make the major contribution to the oily waste needed to produce biodiesel.

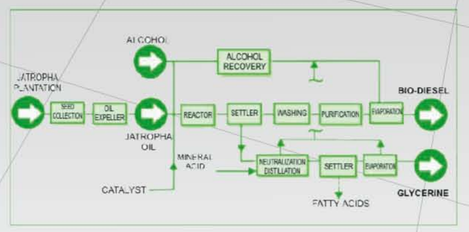
These businesses produce 1,896 gallons/week of oil

Within our project focus on 125th Street between Frederick Douglass Boulevard and Fifth Avenue, there are 10 fast food restaurants. Therefore, they produce 1,5734 gallons/week --> potentially 6293 gallons of biodiesel produced.

Energy(GJ)= 6293x0.14308857 = 900.54 GJ



PRODUCTION OF BIO DIESEL USING JATROPHA AS FEEDSTOCK

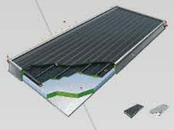


Solar Panels:

Background of Solar Panel Technology

Solar cells provide the energy to run satellites that orbit the Earth. The use of solar panels enables facilities such as satellite TV, telephones, navigation, weather forecasting, and the internet.

They convert day light energy into electrical energy, which we can use for direct--pumps and motors-- or indirect use--battery charging. They are also used to recharge leisure batteries, to extend periods of off grid sites, or become power self-sufficient.



There are three types of solar panels:

- Mono Crystalline - 17% efficiency - Life span of about 20 years
- Poly Crystalline STI - 17% efficiency. (The panel size is often the same, if not smaller than Mono Crystalline panels.)
- Amorphous Silicon 5-6% efficiency - Poor life span of about a couple of years (Large size Watt per Watt compared with Mono or Poly Crystalline.)

The following criterion are used to determine the size of the panel that is needed:

- 9 Watt - Weekend use. (0.5 amps per hour)
- 18 Watt - Long weekend or longer periods, 2hrs TV max. (1 amp per hour)
- 30 Watt - Extended touring TV 3-4 hrs. (1.93 amps per hour)
- 45 Watt - Heading towards self-sufficiency although not unlimited power. (2.78 amps per hour)

For these solar panels, the main idea is to replace energy used in a battery, not to charge them from flat.[6]

Implementation of Solar Panels on 125th Street

The application of solar panels to the roofs of the carts gives the vendor energy that he may use to give back to the community. The solar panels charge a battery within the cart. The battery then powers a panel on the cart designed to illuminate the sidewalk when being stored at night. These can act as backlights for advertisements or as screens that project images.

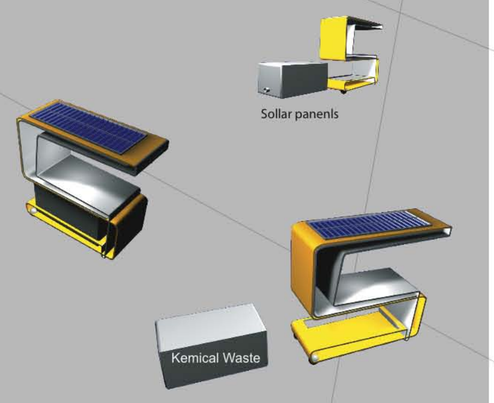
“45 Watt = 2.78 amps per hour”

Chemical Waste:

Background of Chemical Waste

This project focused on chemical wastes produced by the beauty salons along 125th Street. There are a wide range of chemicals used in the hair and beauty industry. Many of these chemicals are hazardous to the environment, but are also of concern to human health. Some of these hazardous chemicals include hair dyes, nail and skin care products, bleaches, straighteners, peroxides, shampoos, chemical peels, hair styling agents, wax solvents, and disinfectants or cleaning products.[7]

Transporting these chemical wastes to a central pick-up point poses the potential problem of spilling while the cart is moving. This is addressed by the use of sorbents. Sorbents are insoluble materials or mixtures of materials used to recover liquids through the mechanism of absorption, or adsorption, or both. Absorbents are materials that pick up and retain liquid distributed throughout its molecular structure causing the solid to swell (50 percent or more). Adsorbents are insoluble materials that are coated by a liquid on its surface, including pores and capillaries, without the solid swelling more than 50 percent in excess liquid.[8]



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