Lafayette College

Environmental Poster Presentation

2010 Fall

Researching Sustainable Ideas for a Brighter Future

LAFAYETTE COLLEGE

Index

Event Summaries

The purpose of this assignment is for students to create posters in a group setting on environmental topics of their choice. The poster assignment is meant to give students an opportunity to research, have knowledge of their topic, conduct, experiment, and report their findings collectively.

In organizing their thoughts and ideas, research, and other factual information, the student groups compose their environmental poster upon which will be judged. Before presenting to a judge, a rough draft is printed and constructive ideas are given by their peers and professors to assist them with their final presentation amongst the judges.

Our judges are professionals from the Lehigh Valley as well as past students of both classes. The judge teams (2-3 judges per team) are assigned five posters to constructively listen to the student's topic as well to inquire about their topic. The student's are then judged on multiple categories some of which include professionalism, grammar, aesthetics, background, research, organization, technical content, and of course, presentation of their poster. Judges score on a scale one to five with five being the best.

This year's poster conference (2010-2011) featured thirty-one posters on multiple environmental topics. The conference is a joint effort of both Civil and Environmental Engineering (CE 321) and Environmental Chemistry (Chem. 252) respectively. The conference took place on Thursday, December 2, 2010 at Lafayette College in the Marlo Room (Farinon Center) lead by Dr. Arthur Kney, Civil and Environmental Engineering and Dr. Steven Mylon, Environmental Chemistry.

Our top five presenters/posters for Civil Engineering (CE 321) were:

First Place: ***"Plant This Not That"***
by: Kelsey Lantz, Andrea Mikol, and Tom Yeager

Second Place: ***"Construction Stormwater Management"***
by: Chris Geary and Don Peters

Third Place: ***"Environmental Endocrine Disruptors"***
by: James Kugel, Tori Pocius, and Meghan Schlitt

Fourth Place: ***"Soaking up the Sun"***
by: Lisa DeJoseph, Rachel Mount, and Megan Young

Fifth Place: ***"Environmental Comparison of Incineration and Recycling of Papers and Plastics"***
by: Hassaan Khan, Avi Mersky, and Kevin Rose

Our top four presenters/posters for *Environmental Chemistry* (Chem 252) were:

First Place: **"Mercury in Aquatic Environments"**
by: Scott Albert, Angela Wnek, Szu-Ying Chen

Second Place: ***"Environmental Endocrine Disruptors"***
by: Tori Pocius, James Kugel and Meghan Schlitt

Third Place: ***"Adulterated Gasoline and Urban Air Pollution in Nepal"***
by: Elizabeth Engoren, Prajesh Adhikari, and Ashutosh Tamrakar

Fourth Place: ***"Removal of Nitrogen from Wastewater"***
by: Elizabeth Parisi and Ariana Senerchia

If you would like more information about these courses, you may contact Dr. Arthur Kney for Civil Engineering (CE 321) at kneya@lafayette.edu or Dr. Steven Mylon, Environmental Chemistry, (Chem. 252) at mylons@lafayette.edu.

Congratulations to Everyone for a Job Well Done!

Posters Summaries

CIVIL AND ENVIRONMENTAL ENGINEERING (CE 372)

POSTER RESEARCH TOPICS

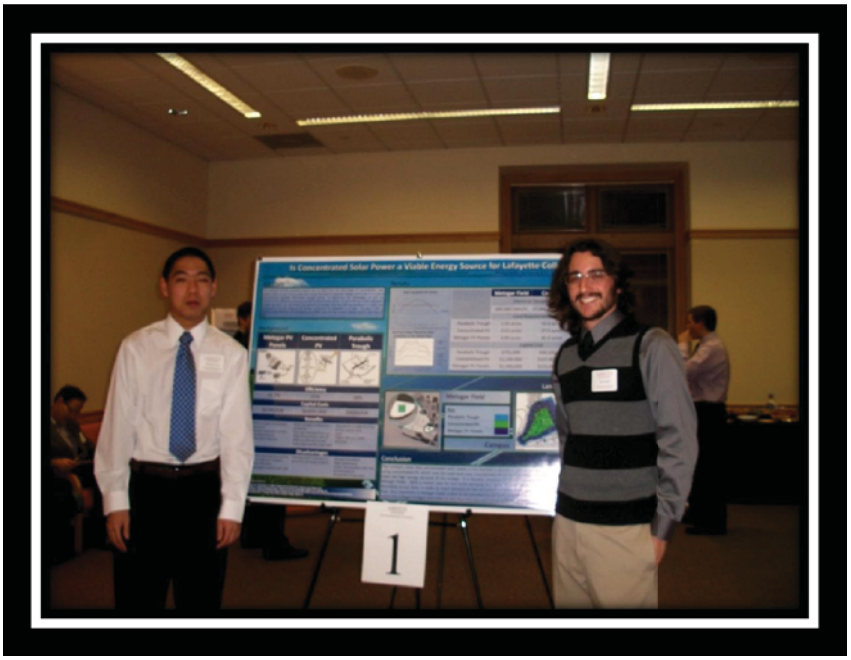
1. ***Is Concentrated Solar Power a Viable Energy Source for Lafayette College***
4. ***Post Construction Stormwater Management Case Study (2nd Place)***
5. ***Agricultural Irrigation***
8. ***Wind Power at Metzgar Field***
9. ***Soaking Up The Sun – Solar Energy at Lafayette College (4th Place)***
10. ***Analyzing Biological and Chemical Indicators to Assess Bushkill Water Quality***
14. ***Conductivity of the Delaware River***
15. ***Dam Removal: Decision Making (Sample Site: Upper Dam and Lower Dam Bushkill Creek)***
16. ***Our Impact on Their Environmental Health***
21. ***Plant This, Not That! An In-Depth Look at Invasive Species of Plants and Their Presence at Lafayette (1st Place)***
22. ***Environmental Comparison of Incineration and Recycling for Papers and Plastics (5th Place)***
23. ***Sustainable Practice on the Quad***
24. ***Submerged Aquatic Vegetation in the Chesapeake Bay***
26. ***The Blueprints For A Green Future***
27. ***Environmental Endocrine Disruptors (3rd Place)***
28. ***Wind Energy from the Past to the Future***
29. ***A Study of Mass Balance in Pervious Concrete***
31. ***Sustainability through Vegetated Green Roofs***

Poster # 1

Is Concentrated Solar Power a Viable Energy Source for Lafayette College

Phil Bellis, Dan Kim, Michael Tsai

The purpose of this research project was to determine the advantages of concentrated solar power, and to see if the technology was feasible to meet the energy demand of Lafayette College and/or Metzgar Fields. It was found that in order to meet the demand of the entire college (27 million kWh/year) solar technology should not be utilized. Metzgar Fields, however, can realistically be powered by concentrated solar technology due to an energy demand of only 300,000 kWh/year. A parabolic trough system is recommended due to a land usage of only 1 acre and cheapest cost in respect to the other forms of solar technology.



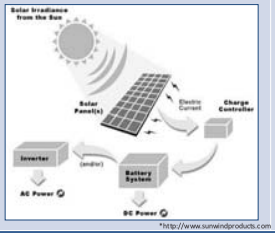
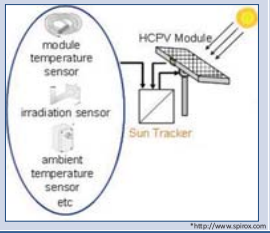
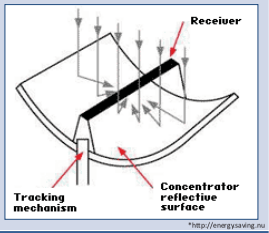
Is Concentrated Solar Power a Viable Energy Source for Lafayette College?

Phillip Bellis, Se Hyung Kim, Michael Tsai

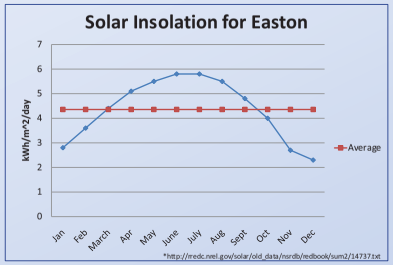
Abstract

The purpose of this research project was to determine the advantages of concentrated solar power (CSP), to see if it can meet the energy demand of Lafayette College, and to see if it is also a economically practical alternative energy source. To determine the advantages of CSP, we compared the efficiency and costs of CSP to that of solar panels. To see if CSP can meet Lafayette's energy demand, we calculated the amount of energy that the CSP can produce in a year and compared it to the amount of energy consumed by Lafayette in a year. To see if CSP is economically practical, we compared the $/KW costs for the current energy source with that of CSP.

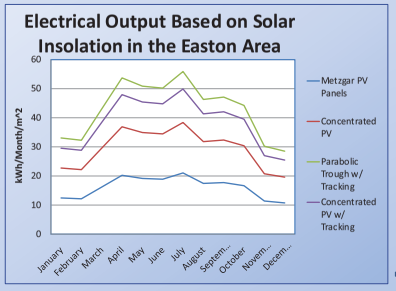
Background

Metzgar PV Panels	Concentrated PV	Parabolic Trough
		
*http://www.sunwindproducts.com	*http://www.spirox.com	*http://energysaving.nu
Efficiency		
13.7%	25%	28%
Capital Costs		
$6700/kW	$6300+/kW	$4000/kW
Benefits		
•Direct sunlight to electricity conversion •Minimal equipment needed •Low Maintenance •Most Easily Attained	•Direct sunlight to electricity conversion •Two axes tracking of the sun. •High Concentration ratio of 1200:1 (1,200 suns on cell) •Uses Triple-Junction Solar Cells	•Focuses the sunlight to a tube of heat transfer fluid •Cost •Higher Efficiency (after inverters)
Disadvantages		
•Cannot automatically track the sun for maximum sunlight. •Lowest Efficiency •Uses Single-Junction solar cells	•Cooling system necessary to assure the cell works properly	•One axis of rotation •High maintenance •Lower concentration ratio than Concentrated PV •Complexity of operation

Results



*http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/sum2/14737.txt



	Metzgar Field	Campus
	Electrical Demand	
	300,000 kWh/Yr	27,000,000 kWh/Yr
	Land Requirement	
Parabolic Trough	1.02 acres	92.6 acres
Concentrated PV	0.52 acres	47.0 acres
Metzgar PV Panels	0.95 acres	85.8 acres
	Capital Cost	
Parabolic Trough	$755,000	$68,500,000
Concentrated PV	$1,200,000	$107,800,000
Metzgar PV Panels	$1,300,000	$115,000,000

Land Usage

*Final Energy Report: Lafayette College. (2010).

Metzgar Field

Key

- Parabolic Trough
- Concentrated PV
- Metzgar PV Panels

Campus

*Lafayette Campus Master Plan: Final Report. (2009).

Conclusion

The numbers show that concentrated solar power is not feasible in powering Lafayette's entire campus. Even using concentrated PV, which uses the least land area, considerable amounts of acreage are needed in order to meet the high energy demand of the college. It is feasible, however, to utilize concentrated solar power for Metzgar Fields. With a master plan for the fields devoting four acres to solar power, the space is available. According to our data, in order to meet demand of the recreation complex, even less land is necessary than that. Our conclusion is Metzgar Fields is best to be powered by parabolic troughs since it is the cheapest, well within the college's budget, and takes up less than the planned 4 acres at Metzgar Fields.

References

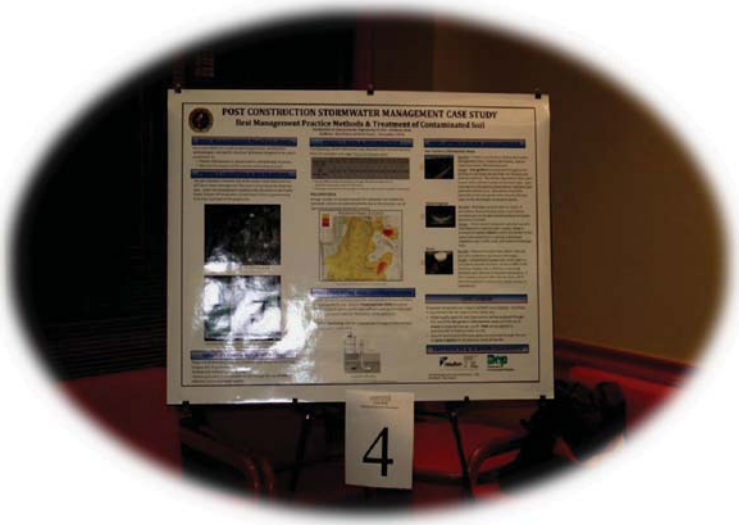
Ristinen, R.A. & Kraushaar J.P. (2006). Energy and the environment. Hoboken: John Wiley & Sons.
MacKay, D. J. (2009). Sustainable Energy – Without the Hot Air. Cambridge, England: UIT Cambridge Ltd.
NREL. (2003). Assessment of Parabolic Trough Technology Cost and Performance Forecasts. Retrieved from http://www.nrel.gov/csp/pdfs/34440.pdf
Final Energy Report – Metzgar Field. (2010). Lafayette College. Easton, Pa

Poster # 4

POST CONSTRUCTION STORMWATER MANAGEMENT CASE STUDY

- Best Management Practice Methods & Treatment of Contaminated Soil

Chris Geary and Don Peters



The poster is on a case study with pending NPDES approvals for a proposed commercial development located within the Jordan Creek Watershed. The land's previous use was an orchard that used pesticides, therefore soil contamination, including lead and arsenic, is present. A product known as Polyacrylamide is used to treat the contamination. Other best management practices (BMP's) proposed for this project are Bio-retention Areas which allow plants to remove pollutants from water, Spray Irrigation which uses collected stormwater to recharge the groundwater on site, and Snouts, which separate floatable debris and oil from water. The use of these 4 BMP's improve the water quality and allow volume control and infiltration goals to be achieved.

POST CONSTRUCTION STORMWATER MANAGEMENT CASE STUDY

Best Management Practice Methods & Treatment of Contaminated Soil

Introduction to Environmental Engineering CE-321 – Professor Kney
Authors: Don Peters & Chris Geary - December 2010

BEST MANAGEMENT PRACTICE (BMP)

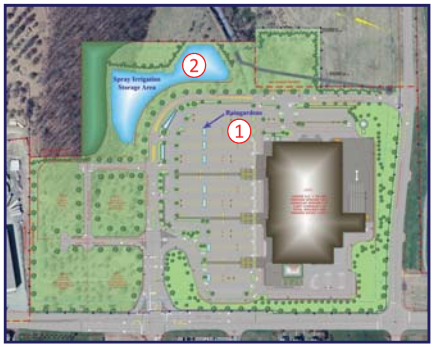
Stormwater BMPs are a suite of planning processes, development methodologies, and specific structural techniques designed to be used in combination to:

- Prevent disturbances to natural systems and hydrologic functions
- Minimize the impacts of disturbances where they do occur

PROJECT LOCATION & BACKGROUND

The site is located in Subarea 103 of the Jordan Creek Watershed Act 167 Storm Water Management Plan and is a Provisional No Detention area. Under Pre-Development conditions the site drains to the Coplay Creek, (Chapter 93 designation is Cold Water Fishery) approximately 0.75 miles southeast of the project site.

Project Location – Aerial Photograph
Plan created by The Newton Engineering Group, P.C. (2010)



Commercial Development with Aerial Photograph
Plan created by The Newton Engineering Group, P.C. (2010)

REGULATIONS & REQUIREMENTS

Phase II Final Rule Requirements (Federal Clean Water Act of 1977) & Chapter 102 Requirements

- Erosion and sedimentation controls
- Reduce pollutants in stormwater runoff through the use of BMP's
- Volume Control and water quality

PROJECT DATA & INFORMATION

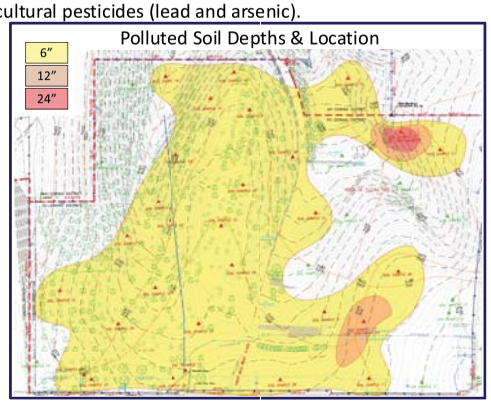
The following rainfall information was obtained from the Pennsylvania State Climatologist web page (http://climate.psu.edu).

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Mean rainfall (1971-2000) (in.)	3.55	2.69	3.74	3.64	4.71	4.35	4.30	4.13	4.55	3.59	3.77	3.53	46.55
2006 Average rainfall (in.)	5.23	2.24	0.9	3.36	2.46	10.95	6.53	3.56	5.88	4.71	4.85	2.27	52.94

- Per the 2006 monthly precipitation average, the total average annual rainfall for the project area is 52.94 inches
- The design rain event for this project is: 100-year return period (rainfall=7.44 inches)

POLLUTED SOILS:

A large number of samples exceed the statewide non-residential standards and are considered polluted due to the previous use of agricultural pesticides (lead and arsenic).

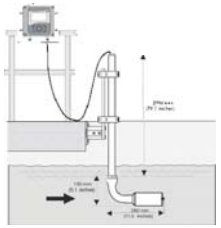


Plan created by The Newton Engineering Group, P.C. (2010)

TREATMENT OF SOIL CONTAMINATION

To help reduce the pollution from the soil a product known as PAM is being proposed for use. Anionic **Polyacrylamide (PAM)** is a water-soluble product used to clarify water effluent coming from disturbed soils & construction sites by flocculation of the pollutants.

Turbidity Monitoring shall be implemented throughout the duration of construction (<100 NTU).



Turbidity Monitor
Catalogue - HACH LANGE CATALOGUE
Source: http://pdf.directindustry.com/pdf/hach-lange/hach-lange-catalogue-2006-2007/5842-4261-_97.html

BMPs APPROVED FOR DEVELOPMENT

Rain Gardens / Bioretention Areas

Benefits – Protect Local Streams, Reduce Stormwater Management Costs, Enhance Site Ascetics, Reduce Impervious Cover, Remove Pollutants
Design – **Rain gardens** are proposed throughout the parking lot and along the perimeter for filtration and pollutant removal. The shallow depressions allow water to pool while sediment settles at the mulch layer. Upon entering the soil/organics/sand mixture, infiltration and pollutant removal occur. Base drains around the perimeter of the rain garden then carry the filtrated water to the stormwater conveyance system.

Spray Irrigation

Benefits – Recharges ground-water by means of percolation; Plants and other biota in soil remove nutrients such as nitrogen and phosphorus; Increases base flow in streams,
Design – Water volume collected in detention pond is over detained to improve water quality. Water is pumped into **spray irrigation** system and applied to the spray fields established on existing undisturbed vegetative areas, buffer yards, and prepared landscape beds.

Snout

Benefits – Reduces floatable trash, debris, free oils, and other solids from stormwater discharges.
Design – Vented hood installed over outlet pipe in a sumped stormwater structure. Forms a baffle in the structure. A deep sum is effective in removing pollutants and reducing of frequent maintenance. It also increases volume within the structure, which allows the pollutant constituents a better chance to separate out.

CONCLUSION

Proposed Comprehensive Program of BMP's accomplishes the Phase II requirements for the Federal Clean Water Act.

- Water quality goals for Anti-Degradation will be achieved through the use of the **rain gardens / bioretention areas** and the use of **snouts** to treat stormwater runoff. **PAM** will be applied to polluted soils to improve water quality.
- Volume Control and Infiltration goals are achieved through the use of **spray irrigation** on the pervious areas of the site.

REFERENCES & ACKNOWLEDGMENTS

DEP Best Management Practice (BMP) Manual – 2006
EPA Website – http://epa.gov

Poster # 5

Agricultural Irrigation

Levi Giese, Phil Hathaway, and Jason Marshalek,

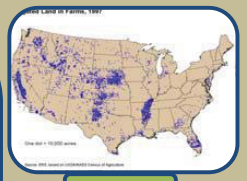
Our poster on agricultural irrigation described the background information and history of agricultural irrigation and then led into the problems that are now occurring with the irrigation. These problems include increased salinity, soil erosion, runoff pollution and competition for water demand and supply. We then found the solutions for these problems which are to use computer controlled irrigation when feasible or for the farmer to use his knowledge and applying how to use the minimal water amount, quality, and when to apply it. There are also options of leaching and drainage available to reduce the problems.

Agricultural Irrigation

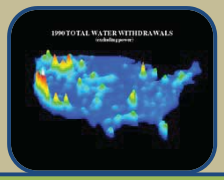
Levi Giese, Phil Hathaway, Jason Marshalek

1. Background:

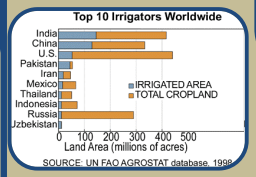
- Irrigation is defined as the artificial application of water to soil. For hundreds of years the process of irrigation has been used to bring water to areas of need. More specifically to dry areas of agriculture. Agricultural irrigation has had many positive effects on society, the most important of which is the ability to grow more food to support our ever increasing population. In some areas of the world were food is scarce, irrigation of crops is essential for any crop out put at all. However, in other parts of the world, irrigation is abused, causing environmental impacts that in some cases could take years to return to their normal order. For instance in the United States alone irrigation accounts for 80 percent of consumptive water use, even though only 16 percent of farm land is irrigated.

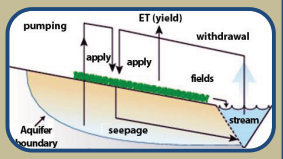


Saline Land



Groundwater Withdrawals



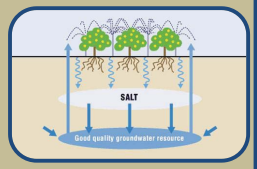


2.Explanation of Problems

2a. Salinity:

- Salinity refers to the dissolved salts that are in all water. When water is used for irrigation there is an increase in the concentration of these salts both in the ground and in the runoff. This can be caused by either the rapid evaporation of the water if the farmer is watering hot dry ground or by over watering. When the water evaporates it leaves the dissolved salts behind, where they can be washed away by the run off. Over watering causes the water table to rise and if the area already has high concentrations of these salts they can rise high enough that the plants can absorb them though their roots. This is especially a problem in irrigation systems that recycles their irrigation water.

The effects of a high saline environment.



2b. Soil Erosion:

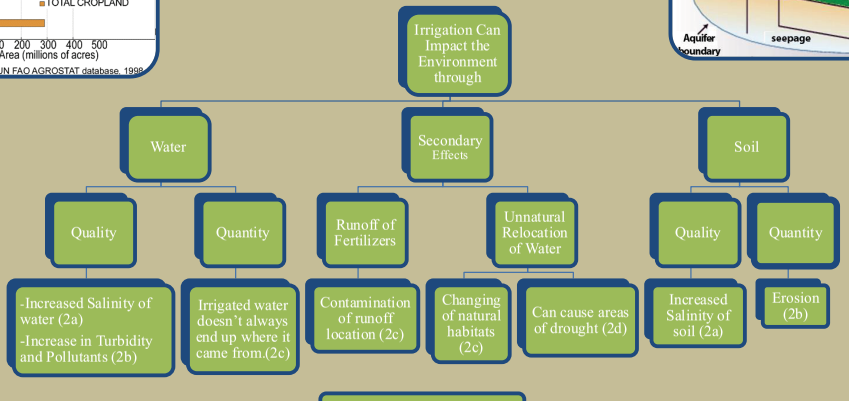
- Soil erosion causes many problems, one of which is the decrease in runoff water quality. An increase in the turbidity and suspended solids results

2c. Runoff Pollution:

- Runoff is a major problem because instead of the polluted water peculating down throw the water table like it should, it runs over the surface and ends up in rivers, ponds, and streams. This polluted runoff not only could case habitat issues for the creatures that live there, but it can also find its way into our drinking water.

2d. Water Demand/Supply:

- Irrigation accounts for approximately 80% of water withdrawn from fresh water systems and has a return rate of 30 %– 60%. That leads to competition for surface water rights.



Types of Irrigation:

Surface/Flood Irrigation: Massive flooding of the area. Usually used in rice and cranberry growing

Sub-Irrigation: Irrigation by forcing water in the ground to raise the water table.

Center Pivot Irrigation: Sprinkler system that rotates about a central point.

Drip Irrigation: Places water directly at the roots of the plant.

Manual Irrigation: Manual placement of water around plants.

Local/Sprinkler Irrigation: Permanent points of water distribution.

3. Solutions

3a. Computer Controlled Systems:

- Computer controlled irrigation systems control the amount of water by taking into consideration the type of plant and the current weather patterns.

3b. Guidelines for Proper Irrigation:

I. Controlled amount of water.
II. Proper quality of water.
III. Proper scheduling.
IV. Appropriate irrigation methods (See irrigation Types).
V. Leaching should be used to prevent salt accumulation.
VI. The level of the water table should be controlled with drainage.
VII. Nutrients should be managed in an optimal way.

I. Amount of Water:

- The proper amount of water depends on the type of crop being grown and the recent weather patterns. A computer controlled system would be best to solve this issue, unless the farmer is knowledgeable of the plant's water needs.

II. Proper Quality of Water:

- Determined by local conditions, the source of the water and the irrigation method. Individual plants also how different sensitivities to water quality so it also needs to be monitored.

III. Proper Scheduling:

Scheduling is crucial to obtain maximum yield of crops. The factors that determine irrigation scheduling are:
-Water holding capacity of the soil.
-Depth of roots.
-Evapotranspiration rate.
-Amount of water to be applied.
-Irrigation method and drainage conditions.

V. Leaching:

- Leaching is the process by which a small amount of irrigation water is applied to help the salts that have accumulated on the surface due to evapotranspiration percolate down through the water table.

VI. Drainage:

- Drainage is the removal of excess water from the above and below the soil surface. This is important to prevent secondary salinization and water logging.

Sources:

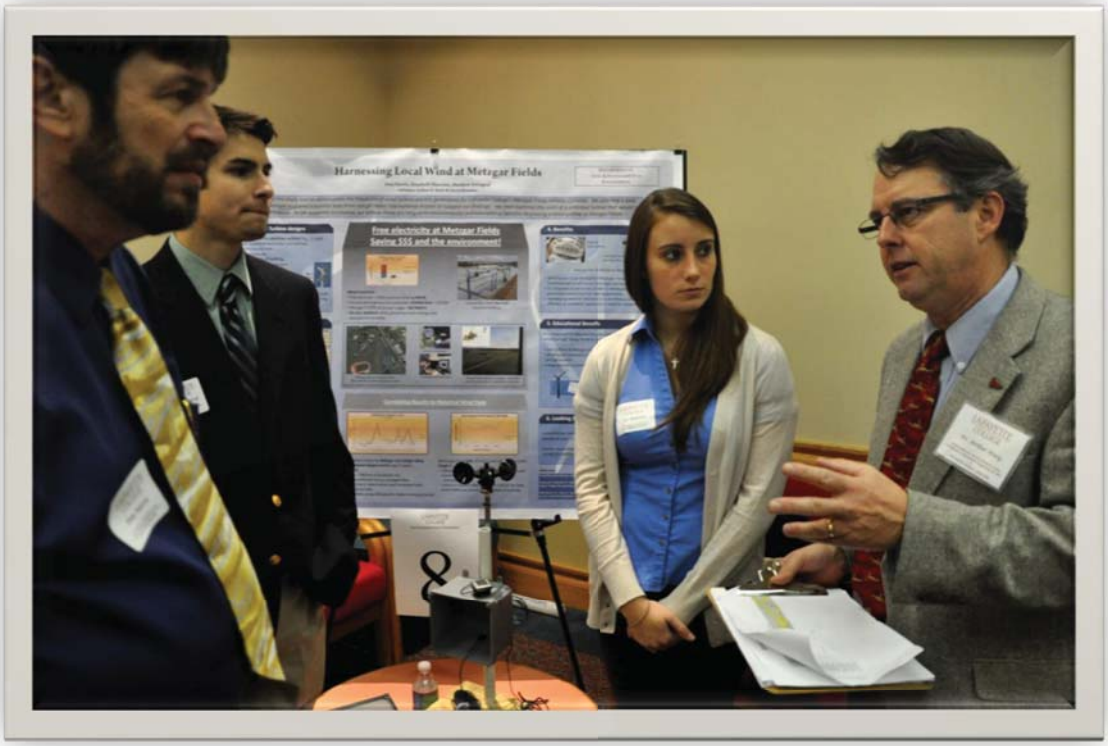
"5. Irrigation with Wastewater." *FAO: FAO Home*. Natural Resources Management and Environment Department. Web. 12 Nov. 2010. <http://www.fao.org/docrep/t0551e/t0551e07.htm>.
"CDC - Types of Agricultural Water Use - Agricultural Water - Other Uses of Water - Healthy Water." *Centers for Disease Control and Prevention*. Centers for Disease Control and Prevention, 10 Apr. 2009. Web. 12 Nov. 2010. <http://www.cdc.gov/healthywater/other/agricultural/types.html>.
"Environmental Impact of Irrigation." *Wikipedia, the Free Encyclopedia*. Wikipedia Foundation, Inc., 30 Sept. 2010. Web. 11 Nov. 2010. <http://en.wikipedia.org/wiki/Environmental_impact_of_irrigation>.
"Irrigation." *Wikipedia, the Free Encyclopedia*. Wikipedia Foundation, Inc., 11 Nov. 2010. Web. 11 Nov. 2010. <http://en.wikipedia.org/wiki/Irrigation

Poster # 8

Wind Power at Metzgar Field

Don Harris, Elizabeth Mancuso, Matthew Zwingraf

The purpose of this study was to demonstrate the feasibility of wind turbine electric generation for Lafayette College's Metzgar Fields Athletic Complex. We collected a data sample from Metzgar and used historical data from Lehigh Valley International Airport to support our findings. We then explored the costs of a potential turbine that would fit Metzgar's needs. As an academic institution, we believe there are long-term environmental and educational benefits to placing a wind turbine at Metzgar Fields.



LAFAYETTE COLLEGE

Harnessing Local Wind at Metzgar Fields

Don Harris, Elizabeth Mancuso, Matthew Zwingraf
Advisors: Arthur D. Kney & David Brandes

Department of Civil & Environmental Engineering

The purpose of this study was to demonstrate the feasibility of wind turbine electric generation for Lafayette College's Metzgar Fields Athletic Complex. We collected a data sample from Metzgar and used historical data from Lehigh Valley International Airport to support our findings. We then explored the costs of a potential turbine that would fit Metzgar's needs. As an academic institution, we believe there are long-term environmental and educational benefits to placing a wind turbine at Metzgar Fields.

1. Harnessing the wind: Turbine designs

The paddle-wheel design of the **AeroCam turbine** (Fig. 1) holds many benefits over traditional horizontal axis turbines.

- Generate electricity at 6 mph
- Low profile and footprint
- Can be mounted on top of buildings

Fig 1: AeroCam turbine capture higher winds on rooftops

Fig. 2: Vertical turbines allow more flexibility in areas with inconsistent wind

Vertical axis wind turbines (**VAWTs**) are also popular for small scale applications and can be pole mounted or on existing buildings (Fig. 2). Cut-in speeds range from 8 – 12 mph.

2. Economics

Constraint on developing wind power:

- Investment costs (auxiliary costs for foundation and grid connection)
- Operation and maintenance costs (O&M)
- Electricity production/average wind speed
- Turbine lifetime
- Discount rate

- Choosing the **right site** to place the turbines is vital to achieving wind power economically.

Results and Analysis	PURCHASE
Total Un-rebatable Cost of the System	$ 362,000.00
Total State, Utility and Federal Rebates	$ 181,000.00
Total Rebated System Cost	**$ 181,000.00**
20 Year Cost of Energy Retail assuming no Turbines are Installed	$ 348,021.12
20 Year Cost or Net Profit with BroadStar System Installed	$ 152,892.67
20 Year Electric Cost Savings	$ 152,892.67
20 Year Implied Discount on Energy Produced	43.93%
Internal Rate of Return (IRR)	5.52%
Simple Payback (years)	9
20 Year Total System Energy Produced - kWh	1,576,800

- The **avoided costs of using wind power** depend on the degree to which wind power substitutes for costs of: fuel, CO_2 emissions, O&M, and capital cost including planning and site work.

3. Community Acceptance

While wind turbines are an environmentally beneficial way to generate electricity, objections are often raised. Some are legitimate, many are based on myth.

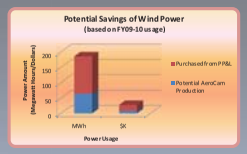
Benefits of wind generated electricity:

- Zero (0) hydrocarbon emissions
- Zero (0) impact on water resources

Concerns (with rebuttal):

- Noise – A turbine's noise is comparable to that of typical household sounds
- Safety – Turbines shut down under adverse conditions and are set back from public access
- Wildlife (birds) – < 0.01% of man caused bird deaths are turbine related

Free electricity at Metzgar Fields Saving $$$ and the environment!



Wind Potential:

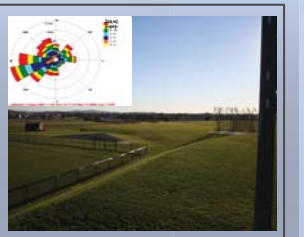
- Five AeroCam 12kW turbines totaling **60kW**
- Conservative generation potential: **65MW/Year** = $9,000
- Metzgar's FY09-10 power usage: **186 MW•H**
- **20 year payback** while providing clean energy and educational benefits

Low profile, roof mounted AeroCam turbine

Metzgar's 80 acre complex allows for a relatively unobstructed flow of wind

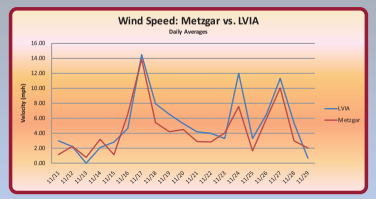
Collection equipment

Analyzing wind speed data



Metzgar Fields looking southwest – dominant wind direction, also as indicated by wind rose

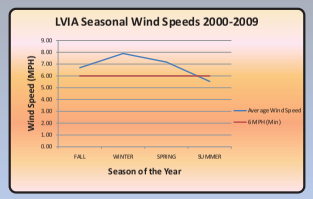
Correlating Results to Historical Wind Data



Wind data comparing **Metzgar and Lehigh Valley International Airport (LVIA)** over 3 weeks.

Graph 1:

- Data collected at proposed site
- Data collected hourly, averaged daily
- Short term observations well correlated with historical data
- Validates using LVIA data for implementing proposal



Wind data from **LVIA,** 20 miles west of Metzgar Fields.

Graph 2:

- Shows seasonal average wind speed over 10 years
- Summer = weakest wind; Metzgar usage is minimal
- Wind is > 8 MPH 40%, > 10 MPH 25% of the time
- 6 & 8 MPH are crucial cut-in speeds of turbines

4. Benefits

Slow the spinning here...

...Increase the spinning here

And see the $$s fall out of the sky!

- Wind power is an emerging technology –more development and implementation will mean more high paying domestic jobs
- As Lafayette strives to be a leader in renewable energy use, wind generated electricity is an ideal opportunity.
- Harnessing wind for electricity is in its infancy; to make it more efficient an academic application is ideal for research.

5. Educational Benefits

It is important to educate the public on both its potential as well as shortcomings being faced as the technology is further developed.

- Link turbine at Metzgar to Lafayette campus
- Develop an interactive console to monitor electricity consumption and generation
- Integrate with student programs and research opportunities

6. Looking Ahead

Lafayette has received approval from an alumni who is willing to donate at least $15,000 in order install a turbine at Metzgar.

Further wind data collection is recommended for a more extensive survey of conditions at the site.

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Poster # 9

Soaking Up The Sun- Solar Energy at Lafayette College

Lisa DeJoseph, Rachel Mount, and Megan Young,

To determine if a reflective surface enhances the efficiency of a solar cell, we created a reflector using aluminum foil and attached it to cardboard sheets and mounted them on a vertical wall behind the solar array on the roof of Acopian Engineering Center. We concluded our efficiency increased by 50% with the reflectors. Because our materials were quite inexpensive, we recommend a future experiment done with more professionally crafted mirrors.

Soaking Up the Sun

Lisa DeJoseph, Rachel Mount, Megan Young

Special Thanks to Professor Kney, Professor Nadovich and George Xiques
CE 321: Introduction to Environmental Engineering

I. Introduction

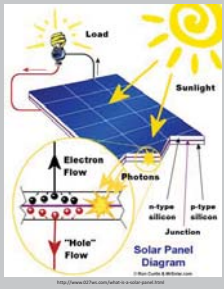
-Photovoltaic cells, or solar cells are the most widespread tool used to collect the energy from the sun's rays.

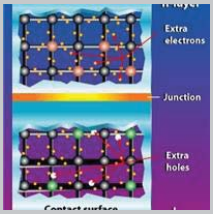
How do photovoltaic cells work?

-Light is composed of photons, which have different wavelengths

-PV cells only absorb certain wavelengths of the solar spectrum

-The energy from the photon is transferred to an electron in the p-layer of the PV cell





- This electron leaves its spot
- Causes imbalance between n-type silicon (excess electrons) and p-type silicone (excess holes)
- Due to the flow of electrons, the semiconductors act as a battery
- An electric field is created where they meet

II. Solar Projects at Lafayette

- Acopian Engineering Center Solar Panels

- An array of photovoltaic cells on Acopian's roof is used by Lafayette college students to determine efficiencies of alternate forms of energy

- Metzgar Field

- Over one year the Metzgar PV system averages 4,800 kWH.
- Lafayette college received a grant from hosting a sustainability conference.

III. General Benefits of Solar Energy Use

- National Security

-Photovoltaic arrays are small and usually kept on site

-Less vulnerable to a terrorist attack

-Reduces the number of "high value" targets

-Reduces grid instability

-Reduces use of dangerous fuels that are hot-spots for a terrorist attack

- Environmental

-Reduce pollutants such as CO_2, NOx, and SO_2

IV. Pre-Experiment Research

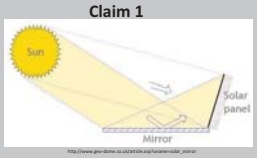
-Solar panels often work below maximum potential

-Mainly in early morning and late afternoon

-Single crystal silicon cells are used in 85% of solar panels created and are 30% efficient

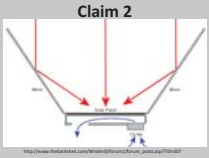
-Claims to improve efficiency

Claim 1



-Install a mirror in front of the solar panel
-Can increase efficiency up to 75%
-Must not block sun from reaching panel

Claim 2



-Install two mirrors surrounding solar panel
-Approximately double the amount of light that hits the panel

V. Possible Problems With Reflectors

-Extra energy from the reflectors during particularly sunny days or heat during the summer, can reduce lifespan of panels

-Cancel warranty

-Cause panels to overheat and may burn out due to excess energy concentration

-High temperatures can cause materials to melt

-Above 50 degrees Celsius the voltage may be decrease by as much as 1/6 of the total voltage of the panel

-Extra energy reflected during the summer months or in warm states may cause problems

VI. Increased Monetary Benefits of Solar Energy

- On-site generation
  - Infrastructure required to transport energy is costly
  - Reduction of the amount of power lost in transmission
- Timing Advantage- solar energy production peaks when energy is most needed

VII. Reflector Experiment

Objectives

-Determine if reflectors enhance the efficiency of solar panels

Procedure

-Construct reflective surface using cardboard and aluminum foil

-Place reflectors on wall behind solar panels and record voltage and amperes

-Construct and hang covering over reflective surface

-Take volt and amp readings after reflectors are covered

Possible Problems

-Wrinkled tin foil may not concentrate adequate light

-Changing daylight affects amount of sun reaching panels due to surrounding building height

VII. Reflector Experiment

Step 1: Install Reflectors Behind Solar Panels

Step 2: Cover Reflectors For Base Readings

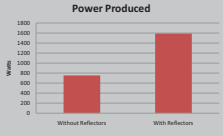
IX. Experimental Data

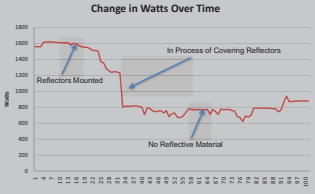
Average Power without reflectors

- 753.16 watts

Average energy produced with reflector

- 1589.068 watts





X. Conclusions

Energy

- The energy produced approximately doubled once the reflectors were put up.

Materials:

- Our materials were inexpensive, therefore with more professionally crafted reflectors efficiency could have increased further.

Time of Year of Experiment:

- Due to the time of year, the sun angle was not optimal for maximum power production.
  - The optimal angle for efficiency is 45 degrees, while placement angle was only about 20 degrees
- ***Because we used such inexpensive materials and saw such a significant increase we can conclude that it may be advantageous to implement these reflectors on a greater scale.***

XI. Future Recommended Experiments

Test if dual reflectors would increase efficiency of panels further

- We propose that this would increase effectiveness unless the reflectors cause shadows on the panels.

Newest Solar Technologies

- Holographic solar power vs. photovoltaic cells

XII. References

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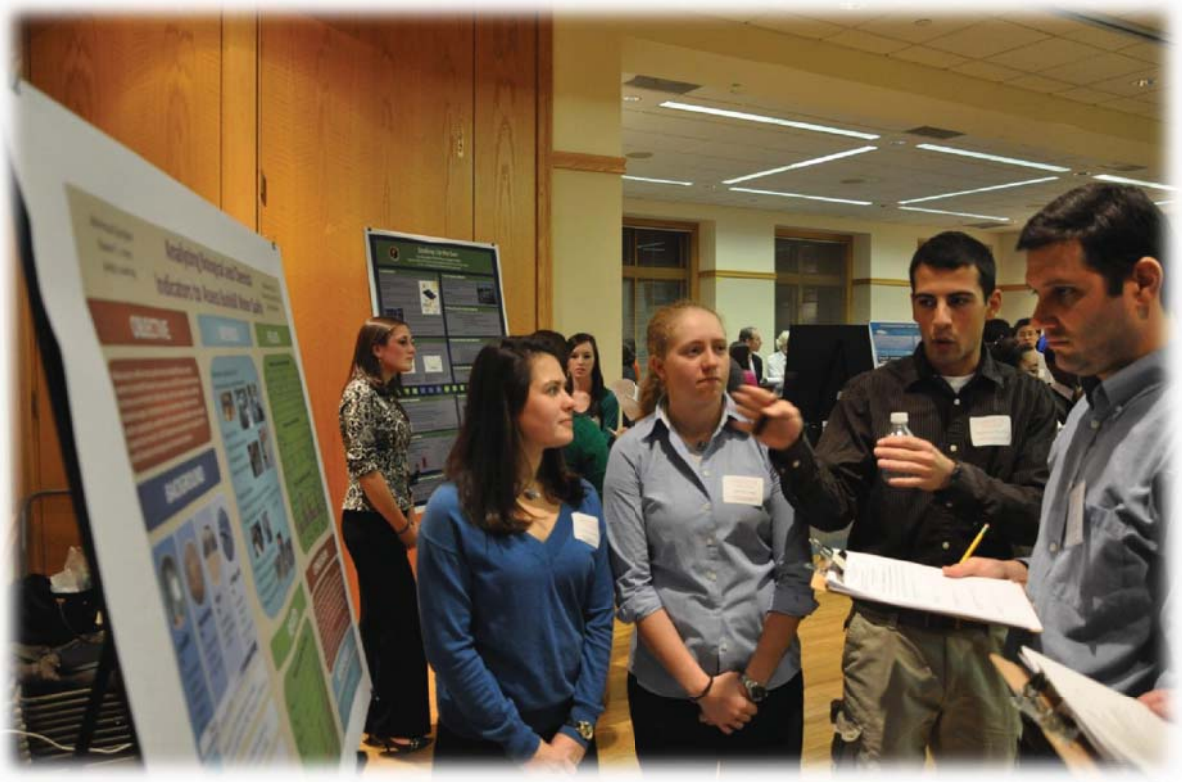
Poster # 10

Analyzing Biological and Chemical Indicators to Assess Bushkill Water Quality

Mahmoud Djindjiev, Rowan Jones, and Janka Lovering,

Follow up on coli form tests performed on Bushkill River over the summer by Bushkill Stream Conservancy and DEP; previous levels were ten times over the limit. Additionally, test the conductivity, alkalinity, dissolved oxygen, temperature, pH, and nitrates. Determine how location, geography, weather, and human activity affect stream quality. Compare test results to DEP allowances and assess the quality of the Bushkill based on biological and chemical indicators.



Mahmoud Djindjiev
Rowan E. Jones
Janka Lovering

Analyzing Biological and Chemical Indicators to Assess Bushkill Water Quality

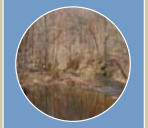
Professor Kney CE 321
Professor Mylon CHEM 252
Professor DeFazio

OBJECTIVE

Follow up on coliform tests performed on Bushkill River over the summer by Bushkill Stream Conservancy and DEP; previous levels were ten times over the limit. Additionally, test the conductivity, alkalinity, dissolved oxygen, temperature, pH, and nitrates. Determine how location, geography, weather, and human activity affect stream quality. Compare test results to DEP allowances and assess the quality of the Bushkill based on biological and chemical indicators.

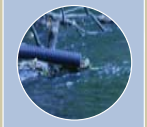
BACKGROUND

Landfill (C)
- Increased human influence
- "dirtier water"



Jacobsburg (D)
- Little human activity
- "HQ" stream

Farm (B)
- Potential agricultural runoff



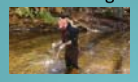
College Hill (A)
- potential industrial runoff
- very close to a dam

Shale → Limestone

Conductivity	• measure of the dissolved ions in water • maximum allowance (TDS): 750 mg/L or 1350 µS/cm
Alkalinity	• measure of water's ability to buffer acid • minimum allowance: 20 mg/L as $CaCO_3$
Dissolved Oxygen	• temperature dependent • minimum allowance: 6 mg/L
pH	• acceptable range: 6-9
Nitrates	• high presence most likely results from anthropogenic sources
Coliform	• total – indicate pathogens may be present • fecal – from warm blooded mammals. E. Coli most common colony

METHODS

Field tests: Conductivity, pH, DO
- instant readings using hand-held meter



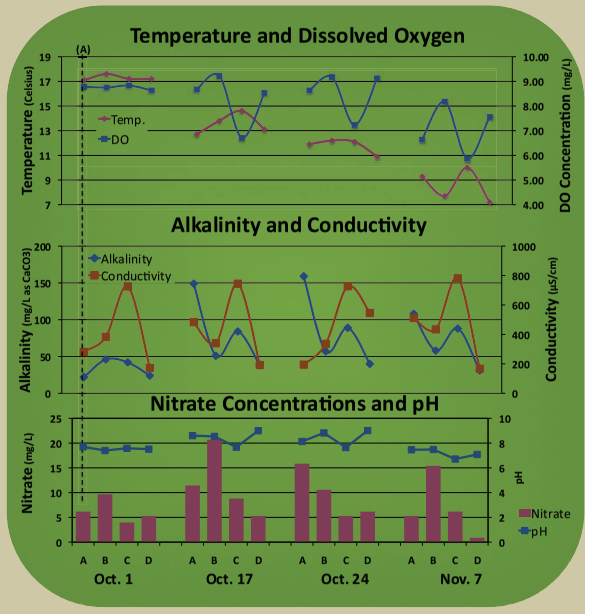
Nitrate Test Kit
- high and low level tests
- comparison to a known color standard


Titration: Alkalinity
- titrate with methyl orange to pH endpoint 4.5
- total alkalinity as mg/L $CaCO_3$ = $\frac{\text{mL acid added} \times N \times 50{,}000}{\text{mL of sample}}$

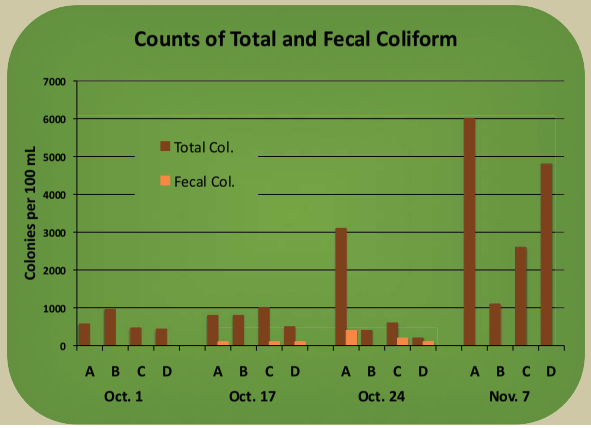

Coliform tests: Total and Fecal
- both feed on lactose
- total: grow at 36.9°C
- fecal: grow at 44.4°C



RESULTS



RESULTS



CONCLUSION

- Water flow did not dramatically affect indicators.
- Alkalinity followed geography for the most part: Southern most point had the highest alkalinity in three out of four trials. Alkalinity and Conductivity appeared to display a direct correlation. As one increased, so did the other.
- One would expect , through denitrification, dissolved oxygen and nitrate concentrations to have an inverse relationship, which they did not.
- It was surprising that as the water temperature dropped during the fall 2010 season, DO did not increase
- Based on our collected water quality indicators, the landfill site had the poorest water quality and the farm site had the highest water quality.

REFERENCES

McGill, A. (2010, Oct. 7). Fecal Contaminants Rising in Bushkill Creek Levels of Bacteria in Some Stretches are Double What They were Three Months Ago. *The Morning Call*

Specific Water Quality Criteria, Pennsylvania Code, Section 93.7 (2009)

Varamo, G. (2010, Aug. 9). Fix Out of the Six Sites on the Bushkill and Little Bushkill Creeks Test Positive for Excessive Levels of Fecal Coliform. *The Express-Times*

Poster # 14

Conductivity of the Delaware River

Tomas Concepcion IV, Carson M. Gentry, and Stephanie Silva

What effect does the Bushkill Creek and the Lehigh River have upon the conductivity of the Delaware River and is this as a valid water quality indicator? After examining our test results and knowledge of the area, we have concluded that the Bushkill Creek and the Lehigh River add a significant amount of conductivity to the Delaware River. We also concluded that conductivity may not be a good indicator for this case because of the naturally occurring high levels of conductivity.

Conductivity on the Delaware River

By: Tomas Concepcion IV, Carson M. Gentry, Stephanie Silva

Purpose: What effect does the Bushkill Creek and the Lehigh River have upon the conductivity Delaware River and is this as a valid water quality indicator?

1.)Background

Delaware River

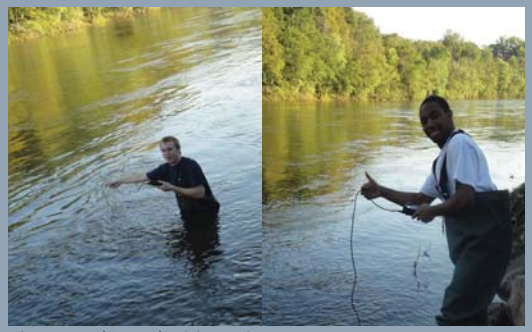
- Used to be a wasteland (0 DO level in the 1950s)
- Delaware River Basin Commission was the first federal resources compact established in 1961 by JFK.
- Bans on phosphate in 1990

Bushkill Creek

- Sobers Run is considered as an "exceptional Value" stream
- Recent data (2009) shows that the quality of water is healthy
  - Average pH value: 7.77 (6-8.5→healthy)
  - Average DO value: 9.375 ppm (above 5-6 ppm is healthy)
  - Average nitrate value: 10.78 (above 10 is healthy)

Lehigh River

- Anthracite coal and steel-producing led to acid mine drainage in the 1900's
- Currently a big recreational area that supports healthy fishing



Figures 1 and 2: conductivity testing

2.)Conductivity:

- Conductivity : a measure of water's ability to pass an electrical current.
- It is affected by the presence of **inorganic dissolved solids:** phosphate, sodium, calcium and iron, etc.
- Conductivity in streams and rivers is also affected by the geology of the area through which the water flows.
- **Limestone** is known to serve as a significant contributor to conductivity.
- Streams that run through areas with clay soils tend to have higher conductivity, because specific materials tend to ionize when combined with flowing water.
- Streams tend to have a relatively constant/natural conductivity. Any drastic changes can serve as an indicator in a change in water quality.

Figure 3: Map of conductivity text sites

Table 1: test results

Field Conductivity Tests				
Location	Conductivity (µS/cm)			
	Test 1*	Test 2**	Test 3**	Average
Delaware River 1	88.25	106.5	102	99
Bushkill Creek	458	525	523	502
Lehigh River	124.8	248	224	199
Delaware River 2	134.35	191.6	184	170

* After 3 days of rain, high water levels and flow

** Normal to low water levels with no rain

3.) Results/Discussion

- It is clear that the conductivity of the Bushkill and Lehigh are significantly higher than the Delaware.
- Mass Balance
  - Approximately 62% change in conductivity along the Delaware River
  - The Bushkill Creek and Lehigh River account for approximately 47% of the conductivity into the Delaware River.
- A high flow rate results in lower conductivity due to dilution from rain water
- A low flow rate results in a higher conductivity since it is more concentrated. This is the base value of conductivity.

4.) Conclusion

After examining our test results and knowledge of the area, we have concluded that the Bushkill Creek and the Lehigh River add a significant amount of conductivity to the Delaware River. We also concluded that conductivity may not be a good indicator for this case because of the naturally occurring high levels of conductivity.

High natural conductivity is found in all three bodies of water. This is due to the geology of the area where the underlying bedrock is composed of mostly limestone and dolomite. These two rock types release a high level of dissolved ions when reacting with the respective bodies of water.

We recommend further studies solely focusing on anthropogenic sources of conductivity in the Bushkill and Lehigh Watersheds. Such studies could look into:

- Grand Central Sanitary Landfill
- Waste Water Treatment Plants: Nazareth WWTP, Easton WWTP, etc.
- road de-icing agents
- concrete weathering
- leaky sewer & septic systems
- SNL Plastics Inc
- Air Products and Chemical Inc.

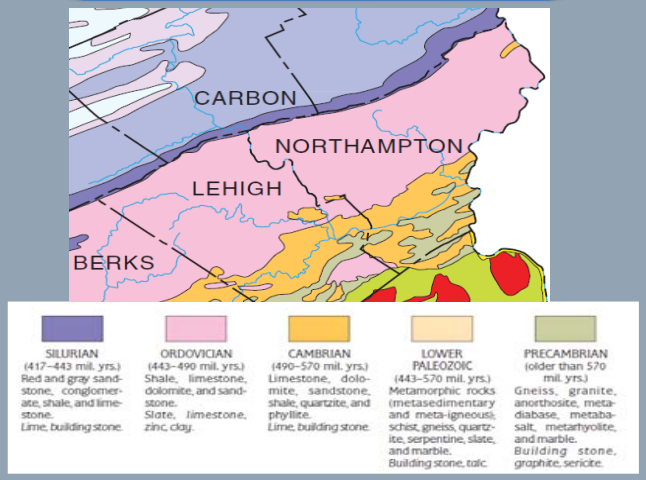


Figure 4: Topographic display of local geology

References:

Delaware River Basin Commission, USGS, Professor Kney

Poster # 15

Dam Removal: Decision Making (Sample Site: Upper Dam and Lower Dam on Bushkill Creek)

Joseph Hattis and Charles Laird

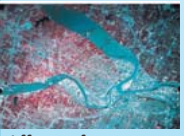
This poster focused on the pros and cons of dam removal. Using test samples of dams on the Bushkill Creek, we took water samples upstream and downstream of each dam. We measured these samples for conductivity, turbidity, water velocity and number of sensitive organisms. If this is a significant trend between upstream and downstream then there could be reason for removal.

Dam Removal : Decision Making (Sample Site: Upper Dam and Lower Dam on Bushkill Creek)

Charles Laird '13 and Joseph Hattis '13
Lafayette College

Introduction to Dam Removal

Dams serve the purpose to control flooding and provide water for consumptive and non-consumptive uses. However, environmental changes brought about by dams include ***drowning of channels and floodplains; altering ecosystems both upstream and downstream of the dam; decreasing sediment flow: and endangering aquatic habitat***. Reasons for dam removal would depend on how negatively the dam has affected the above categories.



Affects of upstream flooding caused by dams

Upstream Spawning areas are blocked off by dams

Upstream sediment buildup at an old dam site

Focus of Project

The last two miles, below 13th Street, of the Bushkill Creek are heavily developed. There are two dams located in this stretch of the Stream (Upper Dam and Lower Dam). The upper dam's dimensions are 11ft by 200ft (height by width) and the lower dam's dimensions are 7ft by 175ft. These dams are large enough to significantly reduce sediment transport and discharge velocity, which encourages contamination build up.

To determine whether the dam should be removed, a study needs to be put together. This study will address a 3 part task:

1.) Outline the nature of likely environmental and economic outcomes of dam removal
2.)Define indicators for measuring and monitoring outcomes
3.) Indicate sources of useful information for researchers and decision makers considering removal

Pros and Cons of Dam Removal

Pros	Cons
•creates more natural river	•corrupts existing ecosystem, natural habitats etc.
•constant water velocities	•increased sediment transport downstream
•more upstream spawning areas	•increase in turbidity and conductivity downstream
•safety precautions	
•increase diversity of species	
•no sediment build up behind dam	

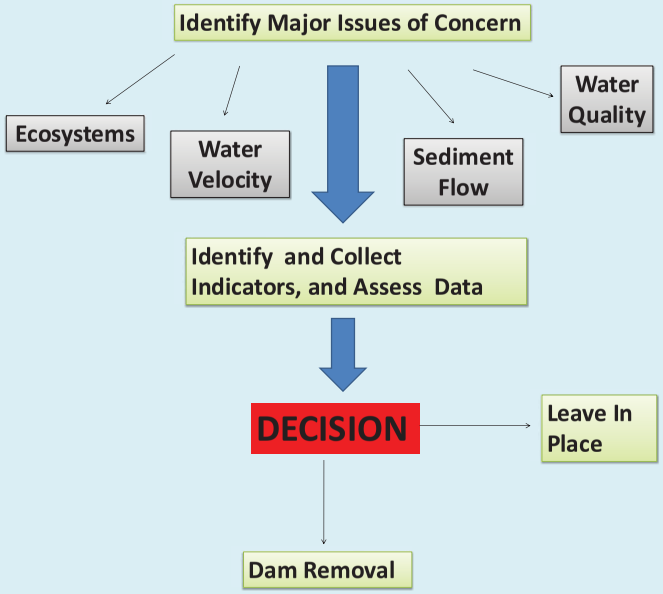
Bushkill Creek Dam Removal 3 Part Task

Environmental Outcomes
Channel Reformation
More spawning area for native trout
Sediment Wave

Indicators
Water Quality (pH, conductivity)
Water Velocity
Sediment Quality (turbidity)
Ecosystems

Sources
Prior Studies (Oregon Marmot Dam)
Research Tools (Dam Removal: science and decision making)
Pros and Cons (Erosion Control: Pros and cons of dam Removal)

Dam Removal Process



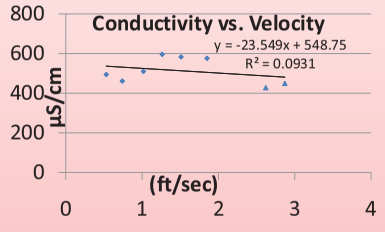
Methods of Obtaining Indicators

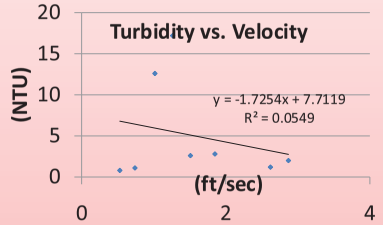
Collecting water samples for conductivity and turbidity downstream of dam

Collecting water samples for conductivity and turbidity upstream of dam

Collecting and counting organisms upstream and downstream of dam

Indicator Results (Graphs and Charts)





▲=Storm Data

Organism Count

	Lower Dam		Upper Dam	
	Upstream	Downstream	Upstream	Downstream
mayfly	8	23	12	56
caddisfly	20	46	7	7
dobson fly	0	3	3	14
scuds/leech	36	4	8	0
aquatic worm	14	0	3	0
snails	7	2	0	0

Key: Sensitive Tolerant

Interpretation of Results

Conductivity vs. Velocity: This relationship is inversely proportional which means that the higher velocity the lower the conductivity. Dams slow water velocity and increase conductivity, which makes poor living conditions for aquatic life. **Favor: Removal**

Turbidity vs. Velocity: This relationship is inversely proportional which means that the higher the velocity the lower the turbidity. Dams slow water velocity and increase turbidity, which makes unhealthy living conditions for aquatic life. **Favor: Removal**

Organism Count: For both dams, the sensitive water quality macroinvertebrate count was larger downstream of the dam than upstream. The tolerant water quality macroinvertebrate count was larger upstream of the dam than downstream. This means that the dams are causing unhealthy conditions upstream. Finally, more macroinvertebrates were downstream than upstream, showing that dams block organism migration upstream. **Favor: Removal**

References

•**David, S. D., and S. Baish, editors.** 2002. *Dam removal: science and decision making.* H. John Heinz III Center on Science, Economics and the Environment, Washington, D.C., USA.

Poster # 16

Our Impact on Their Environmental Health

Kenneth Briotte, Abigail Mitchell, and Lyndsey Munkel

Wetlands deserve our attention because they provide us with water filtration, wildlife habitats, flood and erosion control, etc. We must concern ourselves with their restoration, creation, and making development decisions based on their location. There are a number of human alterations made to wetlands that have negative effects. Some of these include: dredging, shoreline development, and the removal of wetlands for their economic value. Following best management practices and engineering new wetlands are just some of the ways we can reduce our impact on their environmental health.

Wetlands:

Our Impact on their Environmental Health

By Kenneth Briotte, Abigail Mitchell, and Lyndsey Munkel

What is a Wetland?

The U.S. Fish and Wildlife Service defines wetlands as "lands transitional between terrestrial and aquatic systems" that must have one or more of the following three parameters:

- The region must be able to maintain predominantly hydrophytes
- The soil in the region must be mostly undrained hydric soil
- The ground is saturated with water or covered by shallow water during the growing season

Why are Wetlands Important?

Wetlands provide us with:

- Water Filtration
- Wildlife Habitats
- Flood and Erosion Control
- Natural Resources (i.e. timber and peat)
- Recreation

Human Alterations

Dredging

- Removal of sediments from the bottom of estuaries
- Purpose: boat sizes are increasing and more sediments are washing downstream

Above: Dumping of spoils.

Shoreline Development

- Replacement of coastal wetlands and their surrounding wooded areas
- Purpose: to accommodate the increase in population
  - ➢ Shoreline Hardening: the addition of vertical barriers to protect against erosion and flooding
    - ❖ Bulkheads: vertical chemically-treated wooden retaining walls
    - ❖ Seawalls: massive concrete structures
  - ➢ Creation of dikes and impoundments to allow salt hay and commercial salt production

Above: Seawall.

Above: Dikes separating impoundments.

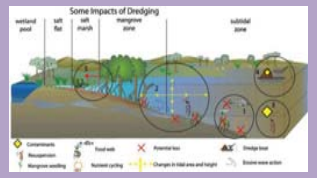
Above: Bulkhead.

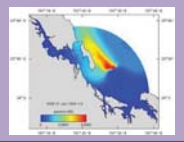
Removal of Wetlands for Economic Purpose

- Urban development has led to:
  - ➢ An increase in impervious surfaces such as houses, roadways, and bridges
  - ➢ An increase in groundwater withdrawal in order to support a larger population
- A greater demand for crops can result in the conversion from wetland to farmland
- Some flood prevention techniques include reservoirs, extensive walls, and dikes

Negative Effects

- Tides move faster and in larger volumes
  - ➢ Increased wave height and erosion
- Increases turbidity
  - ➢ Buries benthic animals
- Spoil may contain toxins
  - ➢ Illegal to dump into oceans
  - ➢ Dumping in wetlands causes elevation increases and smothers biological life



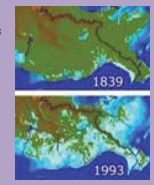


Left: The spoils from dredging outside Port Curtis are dumped 9km south east from Facing Island. High concentrations of heavy metals (Cr, As, Ni) are shown in red as they disperse into the water.

- Eliminates intertidal marshes
  - ➢ Loss of habitat for plants and animals
  - ➢ Hydrology of system is altered
- Erosion occurs at the base of the structures
- Chemicals leach from bulkhead wood, which are harmful to aquatic organisms
- Dikes and impoundments:
  - ➢ Divide wetlands in small pools
  - ➢ Change water flow and water levels
  - ➢ Causes buildup in salinity
    - ❖ Kills organisms sensitive to high levels of salt

- Impervious surfaces:
  - ➢ Increase runoff → flooding
  - ➢ Increase water pollution
    - •Salt, oils, and debris
  - ➢ Prevents soils from filtering rainwater
- Decrease in flood water storage from wetlands:
  - ➢ Increase in the velocity of water
  - ➢ Increase wave heights
  - ➢ Increase erosion → loss of agricultural lands

Left: Effect of impervious surfaces on stream flow rate.



Above: Since 1930, 1.2 million acres of Louisiana wetlands have been lost.

- Economists estimate that, "the loss of 2.5 acres of wetlands leads to a $33,000 increase in the cost of storm damage"
  - ➢ Wetlands provide 23 billion dollars a year in storm protection

Recent Remediation

Selecting BMPs:

Minimum Width(ft)= 2*Slope of Land (%) +25

This equation models minimum width required for an effective vegetation buffer. The equation has a practical limit of $0 \leq x \leq 100$ because as x approaches an angle >45°, the amount of land required for an effective vegetative buffer is too large. Un-cleared land is 2000 times better than cleared land at preventing erosion

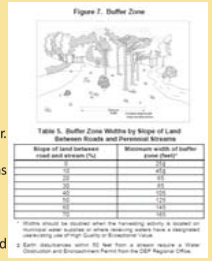


Chart adopted from DEP, timber harvest operations field guide

Through the application of BMPs, erosion can be minimized and removed as a problem for altered and constructed wetlands . Selecting BMP requires consideration of water inflow, water quality desire, soil type, and proximity to sensitive areas

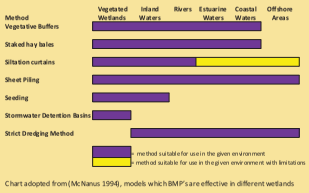


Chart adopted from (McManus 1994), models which BMP's are effective in different wetlands

- Staked hay bales and curtains prevent erosion by trapping particulate matter and slowing the velocity runoff water before it reaches the detention basin (pictured above).
- Siltation curtains efficiency = 36 – 86% depending on the environment (Kent, 2000)

Engineering a Wetland:

Seeding

This is the process of re-vegetating a wetland. Plants are vital to a wetland, they provide habitat for the wildlife in the area, they help filter and store water and they are essential in preventing erosion.

Soil

The soils that make up a wetland are hydric soils. Soil surveys can be obtained via *U.S Department of Agriculture Natural Resources Conservation Service Soil Surveys*. The survey to the right represents a soil profile along the Bushkill River in Jacobsburg State Park

Vegetation:

Common PA Wetland Plants

Alder *(Alnus rugosa)*, **arrow-wood***(Vibyrnum recognitum)*, **birch***(Betula nigra)*, **maple box elder** *(Acer negundo)*, **spicebush***(Lindera nenzoin)*, **sycamore***(Platanus occidentalis)*, **arrow arum***(Peltandra viginica)*, **cattail***(Tyoha latifolia)*, **lily***(Nuphar lutea)*, **sphagnum moss***(Sphagnum spp.)*, **water calla***(Calla palustris)*

cattail*(Tyoha latifolia)*

Steps: Example of vegetation mapping for hypothetical site in CA

Vegetation Association	Plant Species	Area(ha)	Cover(%)
Wet meadow		1.4	90
	Lolium perenne		40
	Hordeum hystrix		30
	Elymus triticoides		20
	Elymus glaucus		10
Seasonal marsh		1.4	50
	Lolium perenne		40
	Juncus balticus		30
	Lotus comiculatus		20
	Polypogon monspiliensis		10
Perennial marsh		0.9	100
	Typha latifolia		80
	Scirpus actus		20
Low-terrace Woodland		0.5	100
	Salix lasiolepis		100

Adapted from *Applied Wetlands Science and Technology* (Kent, 2000)

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Poster # 21

Plant This, Not That! An In-Depth Look at Invasive Species of Plants and their Presence at Lafayette

Kelsey Lantz, Annie Mikol, and Thomas Yeager,

With our research we identified several invasive species of plants around Lafayette's campus and discussed the issues regarding their presence here. We defined invasive species as anything not native to the ecosystem that may cause harm to the environment and other species. These species are introduced to the ecosystem and quickly take over and choke out other plants decreasing diversity and harming animal species as well. After identifying the invasive species on campus, we discussed what Lafayette could do to remediate the problem before it escalates. By using guidelines set up by The National Invasive Species Council, we outlined corresponding methods that Lafayette could adopt. We then looked at the master plan for Lafayette and how our research would play a part in it. The master plan did have several points that dealt with plant species on campus. It also stated that Lafayette is going to become more a part of the green-way that runs through Easton and the surrounding area. If this were to occur, then it will be necessary to ensure that the plants we have on Lafayette's campus would not affect the entire ecosystem of this green-way. We feel that by using this research, Lafayette could make the proper choices in future planting to protect our natural surroundings before it is too late.

"Plant This, Not That!"

An In-Depth Look at Invasive Species of Plants and their Presence at Lafayette

By Andrea Mikol, Kelsey Lantz, and Thomas Yeager

The National Invasive Species Council

Background

What are Invasive Species?

- Not native to ecosystem
- Can be **plants, animals, or pathogens**
- Introduction may cause harm to environment, economy, or human health

Why are they a problem?

- Highly competitive, adaptive, and successful at reproducing
- **No natural predators** to keep populations in check

How can invasive species harm the environment?

- Increase the severity and frequency of **wildfires**
- Alter **nutrient availability** and **water quality**
- Make land more prone to **erosion**

How can invasive species harm other species?

- Spread **disease**
- **Kill trees** and prevent their re-growth
- **Compete** for food, sunlight and space.
- **Interfere** with the reproduction and growth of other species

How can invasive species harm human health?

- **Transmit** deadly pathogens
  - -Ships can transport cholera and **toxic** algae

Where are invasive species found?

- **Every type of habitat**
  - -Oceans, lakes, streams, estuaries, and wetlands
  - -Cropland, fields, and forests
  - -Homes and urban environments

Where do they come from?

- **Foreign** countries
- Transfer from **state to state**
  - Economic advantages
  - Non-intentional transfer

A Classic Example

Purple Loosestrife

- Brought to the US in the ballast of 19th Century boats and as a medicinal herb and spread through waterways and with commercial distribution
- Takes over wetland ecosystems and destroys habitats
- No effective method of control
- Now found in every continental US State except FL and every Canadian province

Objectives of Research

1. Identify the invasive plants on Lafayette's Campus
2. Determine the impact these plants have on the Campus and surrounding area
3. Identify native species which would serve as suitable alternatives for the campus
4. Develop a plan for the college to help reduce it's impact on the environment

Invasive Plants

Burning Bush Euonymus

English Ivy

Japanese Spiraea

Japanese Barberry

Native Alternatives to Invasive Plants at Lafayette College

Invasive Species	Desired Attribute	Native Alternative
Japanese Yew	Evergreen with colorful fruit	Rosebay or Highbush Blueberry
Japanese Spiraea	Rosy –Pink flowers	Pinxter-flower or Service Berry
Weeping Willow	Attractive and fast growing	American Beech or Green Ash
English Ivy	Drought Tolerant Evergreen	Allegheny Spurge or Woodland Aster
Norway Maple	Fall color	Red Maple or Sugar Maple
Periwinkle	Pretty Groundcover	May Apple
Japanese Barberry	Cheap with colorful fruit	Strawberry bush
Burning Bush Euonymus	Fall Color	Fetter Bush

Invasive plants

Periwinkle

Japanese Yew

Weeping Willow

Norway Maple

Strategic Goals of the National Invasive Species Council

1. **Prevent** introduction and establishment of invasive species to reduce their impact on the environment, economy and health of the United States.
2. **Develop** and **enhance** the capacity to identify, report and effectively respond to newly discovered/localized invasive species.
3. **Contain** and **reduce** the spread and populations of established invasive species to minimize their harmful impacts.
4. **Restore** native species and habitat conditions and rehabilitate high-value ecosystems and **key ecological processes** that have been impacted by invasive species to meet desired future conditions.
5. **Maximize** organizational **effectiveness** and **collaboration** on invasive species issues among international, federal, state, local and tribal governments, private organizations and individuals.

Corresponding methods we can adopt at Lafayette

1. Work with administration, plant operations, and landscapers to **halt** altogether the practice of new landscaping with non-native species.
2. Begin a **database**, perhaps within an academic program, that **researches**, **documents**, and **quantifies** the effects of non-native species within our community so we can learn from past behaviors and apply new knowledge.
3. **Research** , **identify, and implement** methods for containing existing invasive species on campus
4. Begin new landscaping projects with entirely **native** plants.
5. **Collaborate** with Northampton County environmental organizations and nearby educational institutions to increase awareness of the importance of preventing and reducing non-native species

Quotes from the Master Plan

"Lafayette College supports best management practices that will enhance local biodiversity... New *landscaping* projects on campus will utilize a palette of native species..."

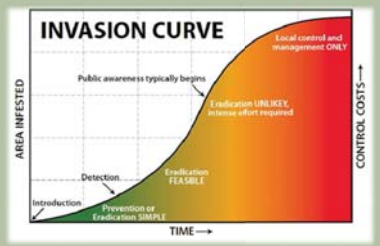
"As a portal through the greenway , Lafayette College has responsibility to the greater community to promote the survival of native species."

"A campus is not a static place; rather, it is a dynamic area that plays hosts to smaller eco-systems while also being connected to the wider ecology of the region around it."

"Lafayette College will act within its power to honor, protect and connect habitat, stream and river corridors within the Lehigh Valley."

Map of Lafayette College and surrounding area, showing the connections or "greenways" between the campus and natural ecosystems. While these greenways help to minimize fragmentation of wildlife ecosystems , they can serve as pathways for invasive species.

Ease of Eradication vs. Time



References

National Invasive Species Council. from http://invasivespecies.gov

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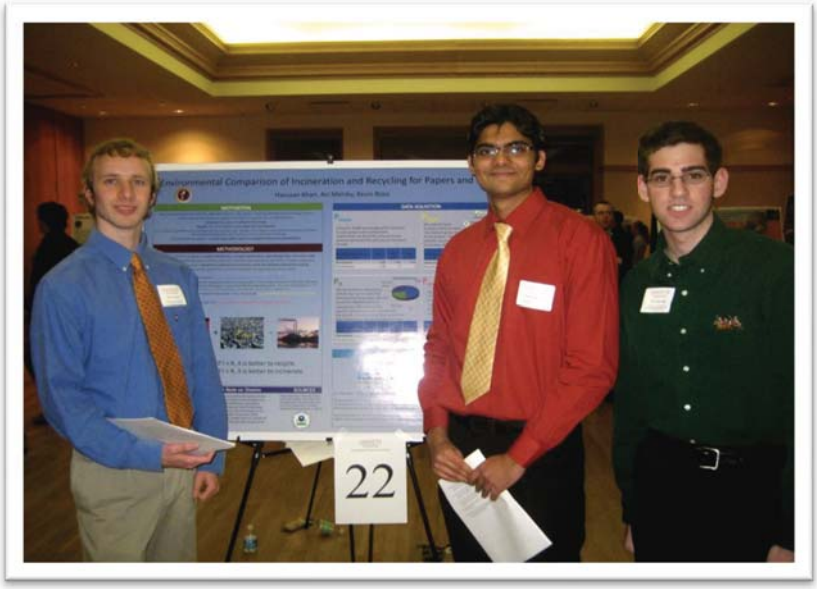
Invasive Plants in Pennsylvania. from http://www.dcnr.state.pa.us/forestry/

Poster # 22

Environmental Comparison of Incineration and Recycling for Papers and Plastics

Hassaan Khan, Avi Mersky, and Kevin Rose

Two possible end-of-life alternatives for a product are recycling and incineration. Each of these scenarios entails the creation of pollution. Our goal was to quantify the amount of carbon dioxide, nitrogen dioxide, sulfur dioxide, and mercury each option produces to determine which is more environmentally benign. We define recycling as the conversion of the product back into its raw materials and incineration as burning with energy recovery. We analyzed this problem using two case studies: newspaper and polyethylene.



Environmental Comparison of Incineration and Recycling for Papers and Plastics

Hassaan Khan, Avi Mersky, Kevin Rose

MOTIVATION

When a product reaches the end of its usable life, there are a few choices: recycling, refurbishment, and energy recovery.

In this study we have chosen to compare recycling and energy recovery as defined below:

Incinerate the product to **convert it into energy**

Recycle it by converting the product **back into raw materials**

Each of these end-of-life scenarios involve pollution of some sort. The goal of our project is to quantify the amount of pollution each produces to determine which option is more environmentally benign.

We will analyze this problem using **two case studies: papers (newspaper) and plastics (polyethylene)**.

METHODOLOGY

The pollutants we have considered are **carbon dioxide (CO_2,) nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and mercury (Hg)**.

Our charge was to quantify the amount of these pollutants associated with recycling and incineration of papers and plastics.

We have computed 2 values: **I, the pollution released by incineration, and R, the pollutants released by recycling.**

These two values will be compared for each of our 4 pollutants to determine the cleaner option.

To find I: We first find $P_{incin,}$ the pollutants released from burning the material.

We then compute the amount of electrical energy produced by this incineration. In the energy market, this electricity effectively offsets the production of an equal amount of energy in a typical fossil-fuel burning power plant. Thus, we must subtract $P_{ff,}$ the pollution that would have been produced to generate the same amount of electricity.

Finally, the incinerated item must be replaced in the market. Thus, we must add P_{repl}, the pollution released in its production.

To find R: We will simply find P_{recy}, the pollution released in the recycling of the product.

$I = P_{incin} + P_{repl} - P_{ff}$

$R = P_{recy}$

If I > R, it is better to recycle.

If I < R, it is better to incinerate.

ASSUMPTIONS

- All products analyzed are burned in isolation.
- All reactions occur in excess oxygen, so everything is fully oxidized in the burning process.
- Transportation to an incinerator and a recycling plant would cost the same in vehicle emissions.
- Electricity generation from turbines is about 45%

A Note on Dioxins

Dioxins are a well known group of toxic substances known to be released in in municipal solid waste incinerators. However they are only formed when chlorine is burned in the presence of organic matter. Since none of the substances contain chlorine, we did not list dioxins because they would not be formed.

SOURCES

- Paper Recycling in Denmark- Policy Issues and Impacts. Royal Veterinary and Agricultural University Denmark.
- Life Cycle Assessment of a Plastic Packaging Recycling System. U. Naples.

DATA AQUISTION

P_{incin}

Using the weight percentages of the elements in each product and stoichiometric relationships, we found the amount of each pollutant generated for each pound of product burned

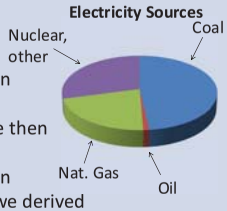
lbs released per lb of product burned	CO_2 x 10^{-3}	NO_2 x 10^{-6}	SO_2 x 10^{-6}
Newspaper	1.80	1.60	3.20
Polyethylene	3.18	0	0

P_{repl}

We used Life Cycle Analyses (LCAs) to assess the cradle-to-grave impact of the product. We took the pollution values at each stage, such as raw material harvesting, refining, and final production.

lbs released per lb of product created	CO_2 x 10^{-2}	NO_2 x 10^{-4}	SO_2 x 10^{-4}	Hg x 10^{-11}
Newspaper	0.0659	.01328	0.0630	3.89
Polyethylene	955	34	193	1.20

P_{ff}



We calculated the electricity in kWh/lb that can be produced from burning the product. We then found the expected pollution released per kWh generated in the U.S. Using these values, we derived the pounds of each pollutant that would have been released per pound of product burned.

lbs saved per lb of product burned	CO_2 x 10^{-5}	NO_2 x 10^{-7}	SO_2 x 10^{-7}	Hg x 10^{-12}
Newspaper	5.07	1.02	4.85	2.99
Polyethylene	12.7	2.57	12.2	7.54

P_{recy}

We used recycling chain LCA data, which include the amount of energy needed for processes like collection, sorting, reprocessing, and distribution. The total energy was then converted to pollution values by the same breakdown used for P_{ff}.

lbs released per lb of product recycled	CO_2 x 10^{-2}	NO_2 x 10^{-8}	SO_2 x 10^{-7}	Hg x 10^{-12}
Newspaper	0.0165	33.2	15.7	9.73
Polyethylene	7630	4.61	2.19	1.35

RESULTS AND CONCLUSIONS

Newspaper

	CO_2 x 10^{-4}	NO_2 x 10^{-7}	SO_2 x 10^{-6}	Hg x 10^{-12}
I	24.1	28.3	9.01	35.9
R	1.65	3.32	1.57	9.73

Polyethylene

	CO_2	NO_2 x 10^{-5}	SO_2 x 10^{-4}	Hg x 10^{-12}
I	9.55	340	193	4.46
R	76.3	.00461	.00219	1.35

For newspaper, I > R for all pollutants. We can conclude (with limited authority) that recycling is more environmentally friendly.

For polyethylene, I > R for all pollutants except for carbon dioxide. Since weighing the effect of one pollutant of the others is beyond the scope of our project, a conclusion cannot be reached here. For example, in areas where eutrophication or acidification are more pressing issues than global warming, the relative weight of NO_2 would be higher than that of CO_2.

Also, we did not take into the interplay of economics and environmental damage. For example, the funds that can be saved by using a slightly more polluting but much cheaper alternative can be reinvested more effectively to abate pollution generation elsewhere.

Poster # 23

Sustainable Practice on the Quad

Xuan Chen,"Spark" Minyan Li, "Sandy", and Xinyi Ma,

The Quad, located in the center of Lafayette, is the most visited place on campus. However, a study of its geology and hydrology conditions shows its current design problematic. Based on site analysis and study of Best Management Practices (BMPs), we propose to install a storm drainage system under the Quad, to build rain gardens along its perimeter, and to construct environmental-and-pedestrian-friendly walkways over it. Our aim is not only to solve the existing problems but also to improve its overall function, turning the Quad into a desired open space for outside recreation and a highlighted campus landscape.

Sustainable Practice on the Quad

Minyan Li, Xinyi Ma, Xuan Chen CE321, Lafayette College

Abstract

The Quad, located in the center of Lafayette, is the most visited place on campus. However, a study of its geology and hydrology conditions shows its current design problematic.

Based on site analysis and study of Best Management Practices (BMPs), we propose to install a storm drainage system under the Quad, to build rain gardens along its perimeter, and to construct environmental-and-pedestrian-friendly walkways over it. Our aim is not only to solve the existing problems but also to improve its overall function, turning the Quad into a desired open space for outside recreation, an attractive green area for group gathering, and a highlighted campus landscape.

Background Study

Site Topography Map

Geography
- Dolomite and limestone.
- Karst formation → sinkholes.

Soil:
- Deep, drained soils formed from limestone bedrock(silt-loam)
- Surface is impervious

Planting and Maintenance:
- Ornamental landscape trees
- High mowing maintenance
- Carbon foot-print.

Rainfall:
- 45 and 47 inches per year
- Distributed uniformly over twelve months

Hydrology:
- Drains to the Bushkill Creek
- No storm drain currently existing on the Quad.

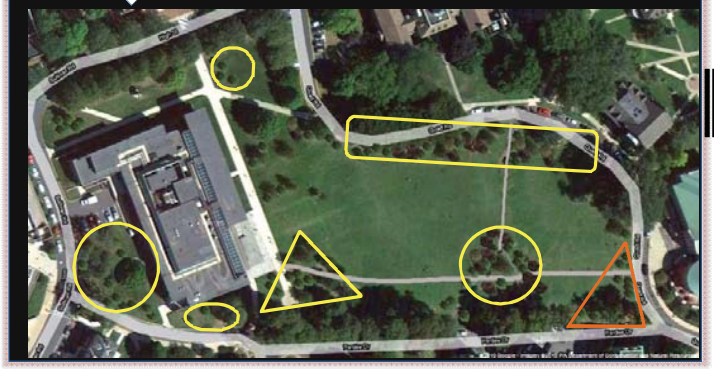
Walkways:
- Two impervious walkways
- Increasing demand of walkway from Farinon Student Center to Skillman Library

Up: Satellite map of the Quad today

Down: New Quad with sustainable practice installed: changed pathway route, rain garden on perimeter, underground drainage system.

Problems

- ***Ineffectiveness of pathway layout***
- ***Accumulation of water and ice on lawn***
- ***Erosion and Runoff to the Bushkill Creek***



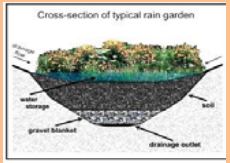
Solutions A

Pathway & Porous Pavement

Replace existing impervious pathways with porous pavement reaching major buildings around the Quad

Benefits:
- ✓ Minimize stress on existing storm sewer systems by reducing peak discharges
- ✓ Reduce winter ice hazards, deicing salt use, and snow removal costs, because snow melts faster on permeable pavement and drains

Solution B



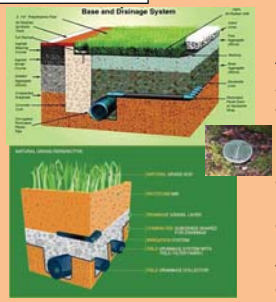
Rain Garden

Three major rain gardens are planted on the Quad perimeter: one near Farinon (South), the one near Kirby (North) and the one located on the southeast of Skillman Library.

A = Area to be planted (total square feet)
D = Distance plants are spaced apart in feet
N = Number of plants needed
$A/D^2 = N$

Benefits:
- ✓ Filter runoff pollution
- ✓ Purify water
- ✓ Create better root system to reduce soil erosion
- ✓ Recharge local groundwater
- ✓ Reduce irrigation needed
- ✓ Reduce potential flooding due to storm or snow
- ✓ Enhance sidewalk appeal
- ✓ Conserve water
- ✓ Remove standing water on the Quad
- ✓ Create habitat for birds & butterflies

Solution C



Drainage System

Use cost effective solutions with low environmental impact to drain away dirty surface water run-off through collection, storage, and cleaning before allowing it to be released slowly back into the environment, such as into water courses.

Benefits:
- ✓ Reduce the impact of heavy rainfall and severe droughts.
- ✓ maintain soil temperature by reducing the heat loss due to excessive surface water.
- ✓ Increase aeration and nitrogen content of the soil which results in earlier germination and better root development.

Future Development

Future sustainable practices considered
- Rain garden → organic garden
- Composting product from Farinon waste food → fertilizer.
- Permeable pavers applied in other campus infrastructure.

Educational values derived

An interdisciplinary study involving art
- Art
- Engineering
- Agriculture and Geology

Campus climate enhanced

Art/ Sports/ Intellectual dialogue

Conclusion

Concerns:
- Native plant for rain garden
- Sink hole under the Quad

Environmental benefits:
- improve water and soil quality
- reduce erosions and runoff
- remove accumulating water on the Quad

Benefits for student:
- More Efficiency for pedestrian
- Enhancing atheistic and educational values;
- Improving the rate of infiltration

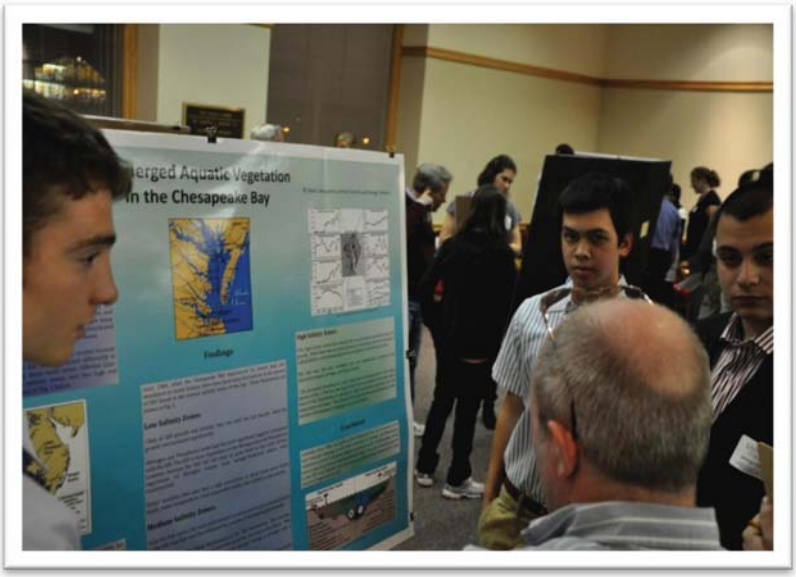
Reference:
- *BMP Manual*
- *Lafayette College 2009 Campus Mater*
- *Google Satellites Maps*

Poster # 24

Submerged Aquatic Vegetation in the Chesapeake Bay

Sam Castagnetta, Jeremy Forsyth, and Georgi Todorov

The Chesapeake Bay is home to a wide variety of life, which is affected by the pollutants in the water. Therefore, it is very important to monitor the water quality. One of the best ways to examine the water quality is to study the Submerged Aquatic Vegetation (SAV). Since 1984, when tests on SAV were first implemented, there have been many fluctuations in the SAV. The strongest correlation is between increased nitrogen levels in the water, and a decline in the SAV of the region.



Submerged Aquatic Vegetation In the Chesapeake Bay

By Sam Castagnetta, Jeremy Forsyth, and Georgi Todorov

Background

The Chesapeake Bay is a huge body of water on the Atlantic Coast of the United States. It serves as a drainage basin for six states as well as Washington, D.C., which covers about 64,300 square miles (Larson). It is home to a wide variety of different species of life, which are all affected by the water quality of the bay. Therefore, it is very important to monitor this water, and make certain that there is nothing there that could potentially alter the environment significantly.

One of the best ways to examine the water quality is to study the Submerged Aquatic Vegetation (SAV), which is easy to collect data on, and is a good indicator of the total water quality of the bay. There are many different types of SAV in the Chesapeake, most of which are distributed throughout the environment based on varying salinities of the water.

SAV is categorized by salinity levels in most water quality studies because each zone supports different types of life, which respond differently to pollutants in the water. In the study, there were seven different Case-Studies, three of which were in low-salinity zones, and two high and medium-salinity zones. These are shown in Fig. 1 below.

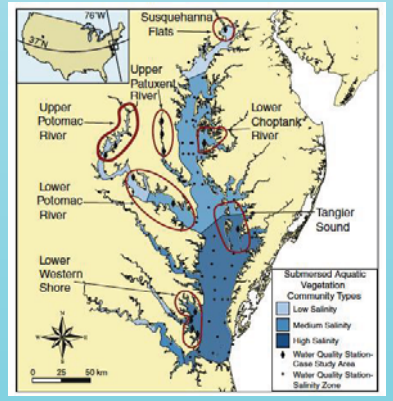


Fig. 1: Salinity Zones on the Chesapeake

The study, which has taken water quality data every year since 1984, has looked at the correlation between the SAV abundance and a number of independent variables both in the total bay as well as in each individual case-study. These included total and flow-weighted concentrations for Nitrogen, Phosphorus, suspended sediment, and Nitrate, as well as both mean and median values for surface-dissolved inorganic nitrogen, total suspended solids, chlorophyll-a, Secchi depth (water clarity), salinity, and water temperature.

Primary Work Cited:

Orth, R. J., Williams, M. R., Batiuk, R. A., Marion, S. R., Wilcox, D. J., Carruthers, T. J., et al. (2010). Long-Term Trends in Submersed Aquatic Vegetation (SAV) in Chesapeake Bay, USA, Related to Water Quality. *Estuaries and Coasts*

Findings

Since 1984, when the Chesapeake Bay experienced its lowest total SAV abundance in recent history, there have been many fluctuations in the amount of SAV found in the various salinity zones of the bay. These fluctuations are shown in Fig. 2.

Low Salinity Zones:

• Rate of SAV growth was initially very low until the last decade, when the growth rate increased significantly.

•Nitrogen and Phosphorus loads had the most significant negative correlation with the SAV. The SAV is more dependent on the Nitrogen than the Phosphorus, however, because the SAV did not start to grow back as fast until stricter regulations on Nitrogen output from sewage-treatment plants were implemented.

•Other variables that also had a high correlation in these areas were Secchi depth, water temperature, total suspended solids, chlorophyll-a, and salinity.

Medium Salinity Zones:

•Like the low zones, this zone experienced an initial period of moderate growth in the SAV, but that was then followed by a series of fluctuating abundances.

•One explanation for these fluctuations is the SAV themselves. One species, labeled *R. maritima*, is known around the world for thriving in hot places. This may have contributed to its high growth period during a drought and a dramatic decline during a very wet season.

•Again, Nitrogen and Phosphorus amounts had the largest correlations to the SAV abundance, with Nitrogen having a more significant impact.

•Other factors that showed a slightly elevated correlation were total suspended solids, Secchi depth, and chlorophyll-a.

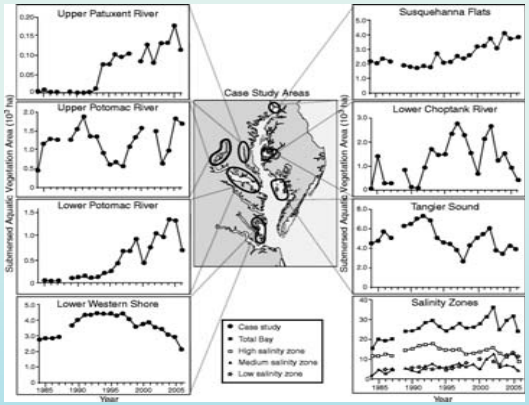


Fig 2: Annual SAV abundance in the Chesapeake bay

High Salinity Zones:

•The high-salinity zones have shown the most problems associated with SAV growth. While there was an initial increase in abundance, that was followed by a sharp decline, which eventually led to levels below that of the start date.

•For this area, the only variables that were significantly correlated were dissolved inorganic nitrogen, and Secchi depth.

• The decreased abundance is most likely due to characteristics of the actual species of SAV. *Z. Marina*, one type of SAV that is prominent in the high salinity areas of the Chesapeake, is sensitive to light penetration; especially when the temperature increases. The climate of the bay area has gradually gotten hotter, therefore, this species is starting to lose its abundance.

Conclusion

Gradually, since 1984, the health of the Chesapeake Bay has increased, as we have reduced dumping of such toxic pollutants as nitrogen and Phosphorus., which have proved to have the highest correlation to SAV. Unfortunately, we still have a ways to go before reaching optimal heath. The lack of continued growth in the SAV is an indicator that the there are still too many chemicals for a large amount of vegetation to exist.

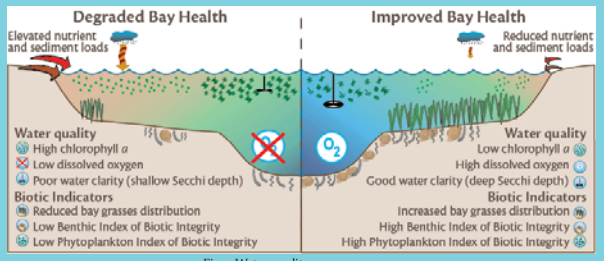


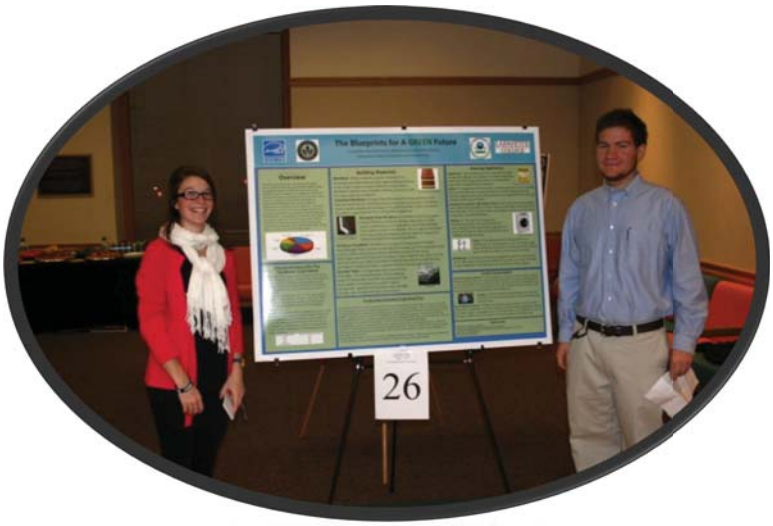
Fig 3: Water quality summary

Poster # 26

The Blueprints For A Green Future

Caitlin Mitchell, Alex Osuchowski, and Gerald Zaremba,

As we build homes for our rapidly growing population, we are depleting our resources and therefore need to build in more environmentally friendly ways, such as to LEED standards, by using more rapid growing materials and materials that are recycled or can be recycled after their useful life. The poster highlighted materials such as bamboo, trex, cellulose insulation, windows, as well as energy star appliances. These materials will reduce the carbon footprint of our homes.

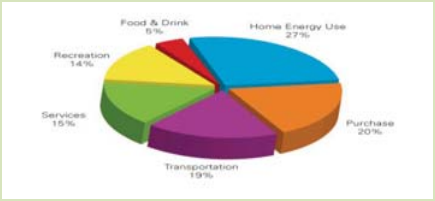


The Blueprints for A GREEN Future

Created By: Alex Osuchowski, Gerald Zaremba and Caitlin Mitchell
Advised By: Professor Greenleaf and Professor Kney

Overview

As we have moved further and further into a green future, home building has gone through radical changes. As population soars and development continues to spread, we can no longer fall on traditional methods for construction where compiling resources was not a major concern. In today's society many alternatives to traditional building materials and more efficient appliances are available as well as practices. In modern construction, it is not only vital to design to reduce our energy consumption, it is necessary to build sustainably and efficiently. As development continues, the demand for materials will only continue to rise, that is why it is important to look into resources that can regenerate quickly or be reused after their intended life cycle. Please join us on a tour of our eco-friendly home.



How can we measure the "Eco-Friendliness" of our homes?

One standard for measuring the environmental impact a house will have on its environment is the LEED standards set forth by the United States Green building Council (USGBC). There are several levels of LEED certification, each is based on the amount of measures in place in a household.

LEED is incorporated early on in a construction project. During the design process, designers work with LEED certified technicians and discuss how to incorporate environmentally friendly measures into a buildings construction.

Recently, LEED has modified its standards to include other measures to measure environmental impact. Points are now awarded for site characteristics such as previous uses of the land, type of land that borders the site (i.e. developed vs. undeveloped), and the proximity of the home to public transportation, shopping centers, and public use areas.

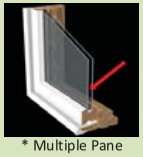
LEED for Homes Certification Levels	Number of LEED for Homes points Required
Certified	45-59
Silver	60-74
Gold	75-89
Platinum	90-136
Total available points	136

Building Materials

Bamboo →Main material used for flooring. It is a extremely abundant material that regenerates quickly (up to 39 inches a day) in various different environments. Bamboo is almost a very durable material, meaning it will last long under all conditions.


* Bamboo flooring Samples.

Insulated Windows → [Low E Gas] Windows that help use the sun to heat during the winter and keep cool air in during the summer conditions. Versus regular, double pain windows $71–$247 and 692–2,825 pounds of CO_2 which is equivalent to 35 to 144 gallons of gasoline.


* Multiple Pane Window. (Two Layers)

Multiple Pane Window → In order to achieve greater energy efficiency, windows can be made with multiple panes separated by an air gap which slows heat transfer and creates a better noise barrier. This air gap can be filled with low conductance gases such as argon or krypton to further increase the insulation qualities.

Cellulose Insulation → Cellulose insulation is composed of 75-85% recycled paper fiber and the remaining 15% is made up of fire retardant such as boric acid or ammonium sulfate. Cellulose insulation has many advantages over other types of insulation. It has a high R-value from 3.6-3.8 per inch and is very safely and easily installed. Because of its high density, cellulose insulation provides a superior thermal and acoustic barrier

Counter Tops –> Using sustainable counter top; *Enviroglas.* It is completely recycled countertop made of 25% binder and 75% recycled glass from local landfills. It contains no volatile organic compounds. Specially EnviroSLAB creates durable counter tops for the bathroom and kitchen.


*EnviroSLAB

So How Does Lafayette Fit Into All of This?

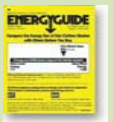
At Lafayette, Students are becoming more and more concerned about the environment. Groups such as LEAP promote a greener campus through recycling and practicing energy conservation. This year under the direction of Professor Veshosky, students have organized a green building club that will soon be a Student Chapter of The USGBC. The group's goal is to build environmentally friendly buildings on campus. The first project for the group slated for this year is a small pavilion for the gardens at Metzgar field constructed from recycled materials such as bottles, tires, and reclaimed lumber; as well as renewable materials like bamboo.

GreenReportCard.org is an organization that rates colleges based on their sustainability practices. Lafayette received an overall score of B and a B for green building in particular. They are credited with using pre-existing structures such as Oechsle Hall for Psychology, Williams Center for Visual Arts, and the recent renovation of Scott Hall for administration.

Part of Lafayette's Master Plan is to have LEED certified buildings on campus. Most renovations performed are to LEED standards, however they fail to undergo the inspection process during renovations.

Housing Appliances

Appliances – Each appliance in the home will be rated *Energy Star efficient.* An appliance receives *Energy Star* status when its energy consumption is substantially lower than the government standards.



*Energy Star Energy Use Guide

Boiler → Energy star certified boilers, whether gas or oil, are on average 6% more efficient than traditional boilers. In order to be energy star certified, Boilers must meet EPA guidelines that require 85% annual fuel utilization efficiency or better.

Compact Fluorescent Light Bulbs (CFLs) →CFLs have many advantages over traditional incandescent bulbs. They provide high quality light with very little heat. They use four times less energy and last up to ten times longer than incandescent bulbs.

Washer → The use of an *energy star* frontloading washer that uses 30-60% less water saving 50-70% operating energy per year. It only uses 18 gal of water per load which saves 7,000 gal of water per year.


* Energy Star Washer

Dryer → The best option for drying clothes is a clothes line. Air drying clothes uses no energy. A gas dryer will be purchased for the home because it burns gas and while an electric dryer burns fossil fuel.

Refrigerator → Using an energy star refrigerator will decrease energy use by 20% which will decrease utility bills by 20%. By using a reduced energy refrigerator it will decrease the use of fossil fuels and gas.

Outdoor Sustainability

Alternative Wood Decking →] Trex Decking is an environmentally friendly outdoor decking material made from reclaimed plastic and wood. The manufacturing process is also eco-friendly as factory refuse/run-off is recycled back into the manufacturing line. The plastic that is incorporated into the Trex material prevents moisture and insect damage which keeps the deck surface looking nice.

Shingles → [Artificial Slate Shingles] Made from recycled materials and are extremely durable. help with cooling and heating houses.

Rain Collection System → Water harvested by theses systems can be used to water lawns and gardens and more recently has been used in applications where grey water usage is acceptable such as washing laundry or for toilets. A ½ inch of rain over a typical house can yield as much as 50 gallons of water for use.

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http://www.sustainablebuild.co.uk/DesignWindows.html
http://www.buildinggreen.com/auth/article.cfm/2008/9/16/Bamboo-Flooring/
http://www.energystar.gov/
http://www.usgbc.org/

Poster # 27

Environmental Endocrine Disruptors

James Kugel, Tori Pocius, and Meghan Schlitt,

Endocrine disruption is defined by the EPA as interference with hormone production, secretion, receptor binding, or degradation. In the environment, there are many of these chemicals, which mimic or block natural hormones and in doing so disrupt normal body functioning (United States Environmental Protection Agency, 2007). Endocrine disruptors are found in many products used in everyday life, including plastic bottles and containers, detergents, food cans, and cosmetics. A major source of endocrine disruptors in the environment is chemicals like pesticides that are released by anthropogenic sources, such as DDT and polychlorinated biphenyls from electrical equipment (National Institute of Environmental Health Sciences, 2010). For our project, we focused on the chemical atrazine and DDE.

Atrazine is a widely used pesticide for control of broad-leaf weeds in farm crops, such as corn and sugarcane. Increasing concentrations of atrazine can be harmful; the chemical has been demonstrated to interrupt hormonal regulation and signaling. While it is successful in killing weeds by inhibiting electron transport, it can adversely affect other wildlife, such as the monarch butterfly, by altering estradiol signaling from an increase in aromatase activity (Solomon et al., 2008). We chose to use the monarch butterfly as a test species for atrazine exposure. Monarchs are a non-target species for atrazine, because milkweed, the only food source for larval monarchs, tends to grow in or around cornfields on which atrazine is widely used as an herbicide. In addition, we researched the effects of DDE on the American Aligators of Lake Apopka.

Environmental Endocrine Disruptors

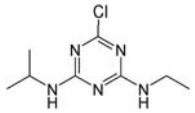
J.D. Kugel, V.M. Pocius, and M.A. Schlitt
Departments of Civil Engineering and Chemistry Lafayette College

Introduction

Endocrine Disruption is defined by the EPA as interference with hormone production, secretion, receptor binding, or degradation (EPA, 2007).

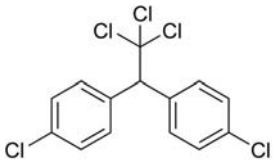
Endocrine disrupting compounds (EDCs) are naturally occurring compounds or man-made substances that can mimic or interfere with the function of hormones in the body. Many of these substances have been linked with developmental, reproductive, neural, immune, and other problems in wildlife and laboratory animals. They can also affect fertility and increase incidence or progression of some diseases, including obesity, diabetes, endometriosis, and some cancers.
Environmental chemicals with estrogenic activity are probably the most well studied, however chemicals with anti- estrogen, androgen, anti-androgen, progesterone, or thyroid-like activity have also been identified.

EDCs are commonly found in plastic bottles and containers, liners of metal food cans, detergents, flame retardants, food, toys, cosmetics. They are also found in biocides such as Atrazine and DDT (NIEHS, 2010).



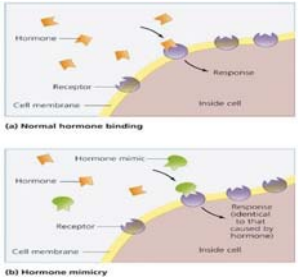
http://www.3dchem.com/molecules.asp?ID=141

Fig 1. Chemical structure of Atrazine (above) and DDT (left). Chart below shows derivatives of DDT.



http://www.tc.umn.edu/~allch001/1815/pesticide/sim/background.htm

EDCs may turn on, shut off, or modify signals that hormones carry, which may affect the normal functions of tissues and organs. They bind to a receptor within a cell and block the endogenous hormone from binding. The normal signal then fails to occur and the body fails to respond properly (NIEHS, 2010).



http://web.bryant.edu/~dlm1/sc372/readings/toxicology/toxicology.htm

Fig 2. How endocrine disruptors work. (a) shows the normal process of a hormone binding to a receptor in the body. (b) Illustrates how an endocrine disruptor blocks binding.

Case Study 1: The Effects of Endocrine Disruptors on the Monarch Butterfly, *Danaus plexippus*

Atrazine (2-chloro-4-(ethylamine)-6-(isopropylamine)-s-triazine) is among the most widely used synthetic pesticides for control of broad-leaf weeds in conventionally farmed crops, especially corn, sorghum and sugarcane. Milkweed, *Asclepias* spp, is a prevalent weed in commercial agriculture and is a pest for which atrazine is used to control. The sole food source of larval monarch butterflies, *Danaus plexippus (L.)* is milkweed. The purpose of this study is to compare the effects of daily atrazine exposure on the monarch butterfly in comparison with effects caused by the potent ecoestrogen 17βestradiol (Hayes et al., 2002; Solomon, 2008).

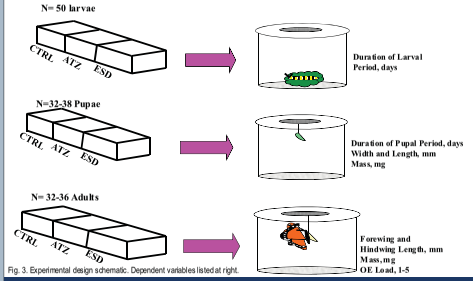


Fig. 3. Experimental design schematic. Dependent variables listed at right.

Methods and Materials

Larvae arrived and were placed in individual containers

Larvae were fed and treated with Spring Water, ESD or ATZ daily.

Upon pupation, pupal lengths and widths were recorded.

Upon eclosion, adult wing measures were taken

Adult mass was recorded and each individual was tested for OE

Healthy adults were released into the wild.

Fig. 4. Images of monarch care, treatment, and release.

Results

Preliminary results show that both atrazine and 17β estradiol have negligible effects on development time, wing lengths, or adult mass in the monarch butterfly. The rate of growth (mg added/day) during the larval period was increased by 8 % and 6.9 % in the ATZ and ESD treatments respectively. Further analysis is underway to see where the extra mass was stored in the ATZ and ESD monarchs.

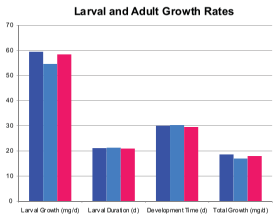


Fig. 5. Graph of varying larval and adult growth rates observed in the 3 treatment groups. Note: standard error too small to depict.

Case study 2: Lake Apopka

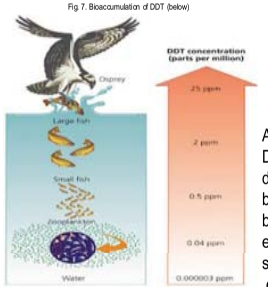
Lake Apopka is the third largest lake in Florida and has been threatened by human development since the 1940's. In 1980 the lake was exposed to a large amount of toxic chemicals, such as DDE, after being improperly dumped by Tower Chemical Company. The EPA deemed the Lake Apopka a superfund sight. Over the past 30 years there have been many tests conducted on the quality of the lake.

http://installings.wordpress.com/page/2/

Fig. 6. Lake Apopka (above) and example of a hatching alligator (below).

http://web.bryant.edu/~dlm1/sc372/readings/toxicology/toxicology.htm

Fig 7. Bioaccumulation of DDT (below)

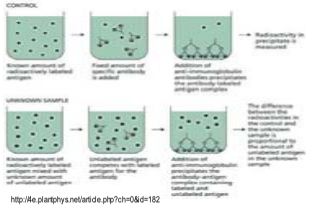


http://web.bryant.edu/~dlm1/sc372/readings/toxicology/toxicology.htm

A degenerate generate form of DDT, DDE is a known endocrine disruptor. Since the chemical bioaccumulates, there have been several case studies on its effect on the tertiary consumers such as Alligators (Guillette et al., 1994).

Methods

Alligator eggs were collected from Lake Apopka and control Lake Woodruff before the sexual development occurred. As the sexuality of the developing embryo is affected by the temperature, the eggs were stored and transported in an incubator. After hatching, observations were made regarding physical abnormalities.
After six months of biweekly measurement of height and weight, blood samples were taken of the Alligators. Blood samples were given with two luteinizing hormone injections over 48hrs. After centrifuging, Radioimmunoassay was performed to determine endocrine effects (Guillette et al., 1994).



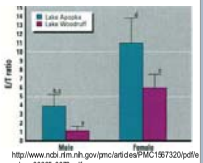
http://4e.plantphys.net/article.php?ch=0&id=182

Fig. 8. Radioimmunoassay process used to determine the endocrine effects.

Results

The 1992 test conducted by the Department of Zoology shows significant differences in alligator growth and viability. Mean Viability at Lake Apopka was 28±7% compared to 50% at control Lake Woodruff. Radioimmunassy results showed increases in estrogen levels for both male and female alligators. Dual Sex mutations occurred in four specimens at lake Apopka.(Guillette et al., 1994).

Fig. 14. Graph of estrogen/ testosterone ratio for alligators from Lake Apopka and Lake Woodruff.



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Conclusions

Through our research and lab work, we arrived at the following conclusions:

•Although environmentalists contend that potential endocrine disruptors are an imminent threat, some chemicals thought to be problematic may not negatively affect all non-target species.

•Because EDCs vary in molecular makeup and chemical lifetimes in the environment, some may effects may be seen in days while others are observed over several decades.

•A better understanding of monarch biology would provide a more complete picture of the subtle effects of EDCs on this species. Less research has been done on sex determination in terrestrial invertebrates, whereas there have been multiple studies done on the effects of EDCs on the alligator.

Recommendations and Future Work

Our research has helped us to formulate new topics for study in this field:

•Future studies are needed to determine if the combination of herbicides, pesticides, and fungicides has additive effects on non-target species.

•Endocrine disruption is a relatively new field of study, so more research is needed to continually monitor the effects of EDCs over time in varying environments.

•Additional testing should be required before new chemicals are released on the market to reduce the probability of potential adverse effects on the environment.

Fig. 10. Photo of DDT being sprayed before it was banned.

http://earth911.com/news/2009/03/16/the-evolution-of-pesticides/

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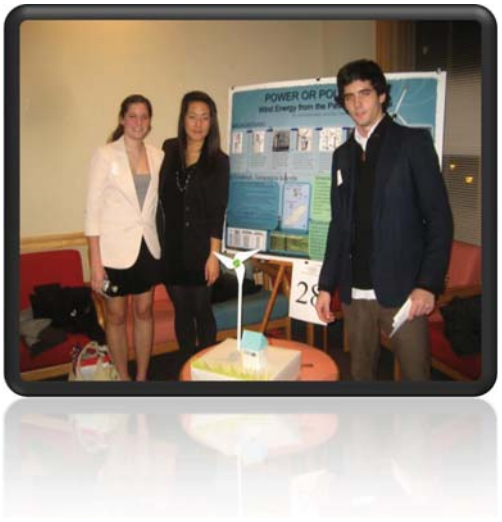
Poster # 28

Wind Energy from the Past to the Future

Johnny Marchand, Janie Pipa, and Ellen Song

Our presentation focused on three specific aspects: the history and development of usable wind power, the economics of using wind energy as a source today, and the example of the San Cristobal Wind Project in the Galapagos Islands. We worked together to research the discovery and development of converting the ordinary power of the wind into electrical energy. The movement of the wind naturally produces kinetic energy, which causes a rotation motion that produces mechanical energy, which is sent to a shaft and converted into electrical energy, channeled to use through a generator.

The earliest mentions of wind power came from the East, Persia, and eventually Denmark both became famous for their inventions. Daniel Halladay brought his model to the United States in 1854. After little adjusting and experimenting, wind turbines development came to a halt. They were given little thought until the world faced a fuel crisis in the 1970's, and the two typical standards were developed – horizontal axis wind turbine (HAWT) and vertical axis wind turbine (VAWT). Today, we group the HAWTs as power plants to produce mass amounts of power.



There are three 80-meter high wind turbines strategically installed in the Galapagos Islands. The endeavor is known as the San Cristobal Wind Project, and provides most of the power to the island. The project carefully avoids wildlife, and contributes positively to the environment. Aside from lowering energy consumption, it also benefits the island but reducing oil spills.

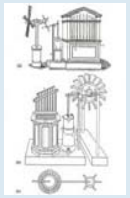
The advantages of wind turbines far outweigh the disadvantages. It is believed that wind energy will rival solar power and together they will overtake the use of fossil fuels. The environmental and financial benefits are irreplaceable.

POWER OR POLLUTION?

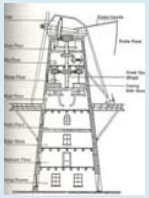
Wind Energy from the Past to the Future

By: Johnny Marchand, Janie Pipa, Ellen Song

BACKGROUND:



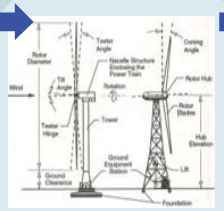
(1) Heron of Alexandria introduces the idea of wind energy with rotors, fueled by air, wind, and water, raised pistons to produce energy.



(2) Europeans produced the Vertical-axis Persian windmill, after experimenting with drag and axes.

(3) Daniel Halladay introduced America to the windmill in 1854, exhibiting his design that included sectional wheels.

(4) Improved windmill–small units were developed as electrical generators to charge batteries, which is later replaced by power lines.



(5)HAWT and VAWT (Horizontal and Vertical Axis Wind turbines) introduced during 1970's when the world faces a fuel crisis.

(6) HAWT and VAWT can have subsystems. Specific to HAWT subsystems are: Nacelle structure and tower

(7) 1975-87, the Federal Wine Energy Program experimented with diverse medium-scale HAWTS until a two-bladed shell tower with variable speed was decided.

(8) Today, prevalent wind power systems occupy a variety of terrains, and operate as commercial power plants.

San Cristobal, Galapagos Islands:

The San Cristobal Wind Project will:

* Reduce the risks of oil spills associated with transportation and delivery of fuel;
* Reduce fossil-fuel emissions and greenhouse gases on a local and global scale;
* Decrease the Galapagos' dependence on the supply of diesel fuel for the generation of electricity in the archipelago;
* Be an example of multilateral collaboration for Climate Change mitigation;
* Contribute to the protection of bio-diversity;
* Provide valuable experience for the global promotion of small-scale, renewable energy power generation and distribution systems;
* Increase the local population's access to non-conventional, clean, energy; and
* Develop public awareness of effective demand-side management and energy conservation practices.

Location of the Wind Turbines:

Year	Power Demand (kWh)	Wind Energy Delivered(kWh)	% Diesel Displacement
2008	7.981.164	4.126.164	52 %
2013	10.186.114	4.887.240	48 %
2018	11.808.498	5.375.724	46 %
2023	13.689.286	5.932.941	46 %
2028	15.869.643	6.626.638	42 %

Ecuador's unique biodiversity

- 2,500 species of land vertebrates
- 11.5% of the world total 34 plant formations
- 20,000 species of vascular plants, 1.6% of the Earth's species
- 2,200 bird species

Advantages:

•Reduces:
• consumption of fossil fuels for electricity production
•production of greenhouse gases/ pollution
•provides extra income for farmers
•Wind is a renewable energy source

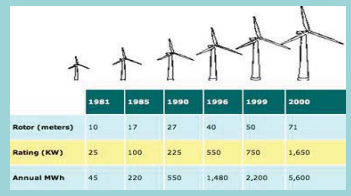
Disadvantages:

•Wind generators are only feasible in certain areas
•Each wind turbine kills about one bird per year
•Wind generators make a humming sound that can be annoying
•Wind turbines are tall so it blocks the views of scenery

ECONOMICS:

Four Drivers of Wind Economics:

1. Technology:

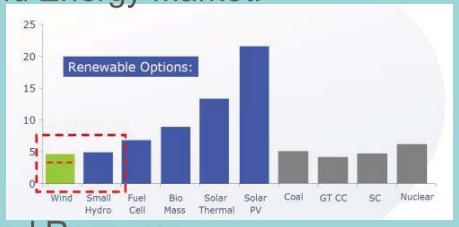


	1981	1985	1990	1996	1999	2000
Rotor (meters)	10	17	27	40	50	71
Rating (KW)	25	100	225	550	750	1,650
Annual MWh	45	220	550	1,480	2,200	5,600

11. Capital Cost:

Approximate installing cost of wind energy facility = $1.5 million/MW

111. Wind Energy Market:



1v. Wind Resource:

WIND ENERGY = WIND VELOCITY

Poster # 29

A Study of Mass Balance in Pervious Concrete

Andrew Bahr, Hannah Griesbach, and Muna Siddiqua

We wanted to determine how much copper can be removed from solution by the pervious pavement (concrete) plug within 24 hours. We took samples in certain time intervals and analyzed how much copper was left in solution for each. Next, we smashed up the plug into small pieces, acidified it, and analyzed it to see if it is actually absorbing the copper. This experiment is supposed to simulate what the rate of copper absorption would be in the natural environment. Copper is a representative for other toxic metals such as lead and cadmium which come off of cars that can be dangerous in excessive amounts.

A STUDY OF MASS BALANCE IN PERVIOUS CONCRETE

Andrew Bahr, Hannah Griesbach, and Thafhim Siddiqua

Special Thanks To: Austin Weidner, Derek Ridinger, Anthony Giralo, Matthew O'Loughlin Professor Arthur Kney, Professor Anne Raich

Introduction

- **Pervious Pavement**
  - Porous concrete or any paving material in general
  - Often used for parking lots, sidewalks, driveways, etc.

- **Why is it Sustainable?**
  - Storm water runoff filters through the pervious material reducing erosion and increasing groundwater recovery
- **Materials**
  - Pervious pavement and common concrete are made up of similar materials but there is less cement and sand used in mixing pervious concrete
  - Less cement creates large spaces in the mix

Figure 1: Cement mix

Past Studies Done at Lafayette

- **Area of sustainability covered**
  - The ability of pervious pavement to filter heavy metals in the environment

- **First study done:**
  - Studied: the interaction between the materials that make up pervious pavement and common heavy metals

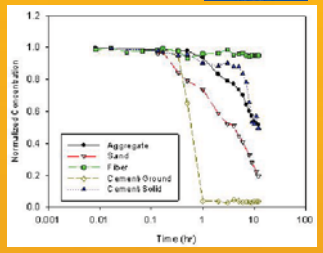


Figure 1: Copper concentration for the ingredients 12-hour batch test

- **Second study done:**
  - Studied: the interaction between an increase in fiber and the speed of copper removal with the hypothesis that copper removal would increase
  - This hypothesis was shown to be incorrect
- **Ongoing research being done:**
  - Focus: improving water quality enhancement properties of pervious pavement
  - Iron filings added to see if they improve copper absorption by way of ion exchange

Figure 3: Permeability test and batch test

Mass Balance: Our Experiment

- The plug will be submerged in an aqueous solution of Cu for 24 hours
- The amount of Cu absorbed by the plugged will be analyzed through a comparison of the concentrations of the solution before and after submersion
- The plug will be crushed and acidified with 1 M HCl to find out how much copper was actually absorbed by the plug

Methods

Batch Test:

1. Beaker is filled with 3500 mL of DI water
2. Cu solution of 5.00 ppm is added
3. Plug is submerged in the beaker and timer is started
4. 5 mL samples are taken at specific time intervals
5. Plug is removed and the volume of the remaining solution is measured

Figure 4: Pervious plug, samples taken, and solution being filtered

Crushing/Acidifying Procedure:

1. Massed the sample
2. Compressed the sample to begin the smashing process
3. Smash the compressed sample with a hammer until the pieces are about less than half an inch in diameter
4. Massed the sample again
5. Poured 1L of 1 M HCl into the same container holding the crushed sample
6. Took 5 mL samples at 15 min. and 24 hrs.

Figure 5 & 6: Plug being acidified with 1 M HCL

Economic Sustainability

Advantages

- Create savings in terms of less land set aside and cost for development of retention basins.
- Reduces automobile hydroplaning decreasing insurance costs
- Does not require a drainage system saving a lot of money!

Disadvantages

- More expensive than traditional asphalt.
  - Asphalt: about $0.75 psf
  - Pervious pavement: about $2.50 psf
- Easily be compromised by plowing in northern climates or by wind erosion in windy regions disrupting the filtration process
- Requires a lot of maintenance because grit or gravel can block the pores

Data and Results

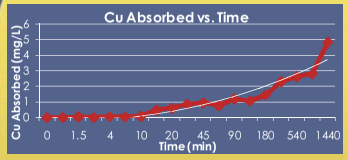


Figure 5: Cu Absorbed vs. Time – Graph showing the amount of copper absorbed by the plug over a period of 24 hours

START

	Conc. (ppm)	Volume (mL)	Mass (mg)
Beaker	5.065	3500	17.727
Total			17.727

END

	Conc. (ppm)	Volume (mL)	Mass (mg)
Beaker	2.212	3452	7.636
Sum of Tubes	vary	5 each	0.373
Core (15min)	9.317	1000	9.317
Total			17.326

Figure 6: Mass Balance Analysis: Table showing the starting weight of the plug before submersion and weight after submersion

Conclusions

- Acid was added to the end solution to put the copper back into solution
- The concentration when measured by the AA was much higher; that indicates that the mechanism of removal is pH driven
- It is unknown whether or not that mechanism is precipitation or ion exchange
- The mass balance was within 2% accuracy

Future Experiments

- Testing the absorption rate of other heavy metals that are not natural to the environment in excessive concentrations like lead, magnesium, or arsenic from human interference
- Testing the filtration abilities of pervious pavement with salts and organics

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Poster # 31

Sustainability through Vegetated Green Roofs

Elena Niemi and Binh Pham

A study conducted comparing a conventional green roof and normal roof with the unconventional green roof designs of grass roof, potted plants roof, and vines roof. A comparison between water retention, water quality, weight, usable space, cost, maintenance, and shades was conducted and processed. Our results indicate that grass path retained the most runoff, but had higher levels of turbidity, conductivity, and alkalinity than the others. Out of the green roofs, the Traditional green roof retained the least runoff, is most expensive, and heavier than the others, but it requires less maintenance. The roof that is most balanced in all area of comparisons is the "Umbrella & Potted Plants" roof.

Sustainability through Vegetated Green Roofs

Binh Pham (Kevin Vo)
Elena Nieme
Robert Elliot

Abstract: A study conducted comparing a conventional green roof and normal roof with the unconventional green roof designs of grass roof, potted plants roof, and vines roof. A comparison between water retention, water quality, and shades was conducted and processed and the results are bellow:

Two main types of green roof:

- **Intensive-** Is a green roof that has bigger plants and a deeper soil and growing media than extensive green roofs. The media is 10 inches thick or more and typical plants for an intensive green roof are trees and shrubs.
- **Extensive-** Is a green roof with a very shallow media layer that's about 1 inch thick. Typical plants on an extensive green roof are mosses, sedums, and low-growing grasses.

Traditional Green Roof Structure

Background:

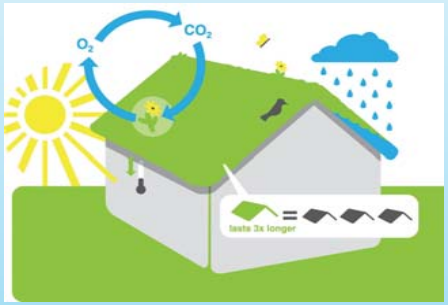
A Green Roof is a roof or side of a building of a structure that has vegetation instead of regular concrete.

Traditional Plants:

Sedums are the typical choice for the vegetation on green roofs because it has the ability to conserve water by storing carbon dioxide in their plant tissue. Therefore, they last longer in extreme weather conditions and you don't have to water them that often.

Benefits:

- Filters water/air
- Reduce storm water runoff - Retain water
- Act as a rain water buffer
- Extend the life of the roof: UV and acid rain protection
- Acts as Insulator - reducing heating and cooling cost
- Increased property value
- Clean Pollutant in biomass
- Absorbs carbon dioxide and produces oxygen
- Provide wildlife habitat
- Provide noise reduction
- Increase Aesthetic Value



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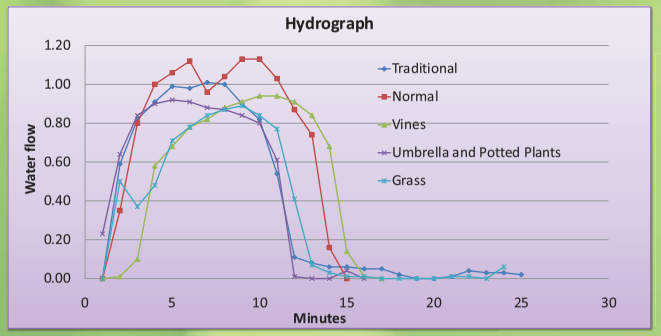
Roof Descriptions

1) **Normal roof-** Standard Roof with no vegetation.
2) **Traditional Green Roof-** Contain a medium, drainage layer, and sedums as vegetation.
3) **Grass Path-** Contained grass on top of soil with a path.
4) **Umbrella**- Contain potted plants with an umbrella.
5) **Trellised**- Contain potted vines, which was elevated.

Conclusion	Weight	Usable Space (%)	Cost Extra (USD/ft²)	Shade (%)	Maintenance	Turbidity (NTU)	pH	Alkalinity (mg/L CaCo3)	Nitrite (mg/L N)	Conductivity (us/cm)
Normal (1)	143	100	0	0	None	.47	7.1	35	0	165
Traditional Green Roof (2)	286	0	$37	0	Low	5.43	6.9	38	0	241
Grass & Path (3)	261	100	2.5	0	High	60.25	7.18	40	0	418
Umbrella & Potted Plants (4)	191	~55	2.44	~66	High	5.38	7.18	28	0	209.65
Trellised Canopy (5)	202	~80	2.11	~85	High	7.18	7.18	20	0	220



Conclusion:

- Grass path retained the most runoff, but had higher levels of Turbidity, conductivity, and alkalinity than the others
- Out of the green roofs, the Traditional green roof retained the least runoff, is more expensive, and heavier than the others, but it requires less maintenance
- None of the water samples had any nitrite
- All of the green roofs retained more water than the normal roof without any vegetation

Reference:

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Photo Gallery


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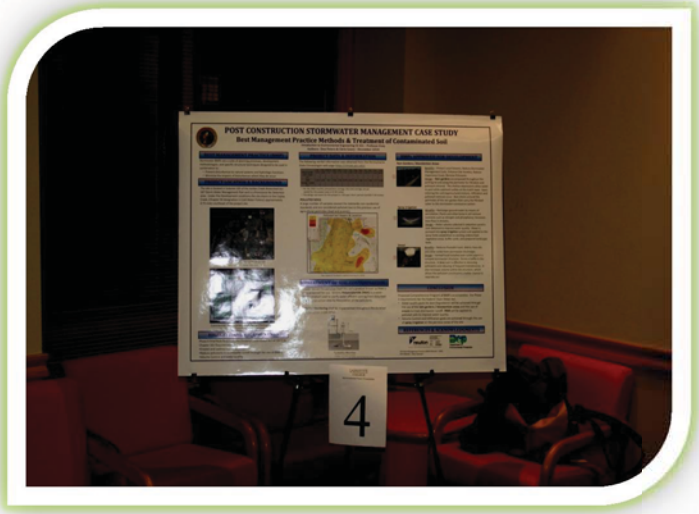
POST CONSTRUCTION STORMWATER MANAGEMENT CASE STUDY
4


LAFAYETTE COLLEGE


Environmental Endocrine Disruptors
27


3

Producing Team

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