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EXISTING BUILDING PERFORMANCE DESIGN:

- UNDERSTANDING THE PROBLEM
  - ENERGY USE & RESOURCES
  - WATER USE & RESOURCES
  - BENCHMARKING
- DESIGN METHODOLOGY
  - IDENTIFY OPPORTUNITY
  - EVALUATE MEASURES
  - CREATE PACKAGES
  - MODEL ITERATIVELY
- CASE STUDY: WOODSIDE MILL COMPLEX
  - PROJECTED LEED 2009 GOLD

CONTENTS:

K. Daryl Carrington, Ph.D., AIA, LEED AP+Homes

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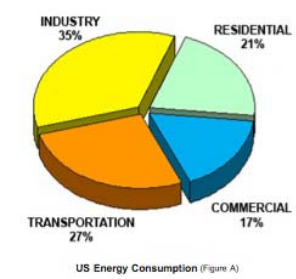
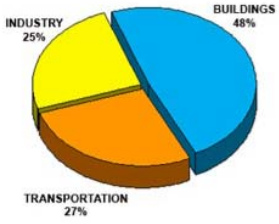


US Energy Consumption (Figure A)



US Energy Consumption (Figure B)

In the United States alone, buildings account for:

- 72% of electricity consumption,
- 39% of energy use,
- 38% of all carbon dioxide (CO_2) emissions,
- 40% of raw materials use,
- 30% of waste output (136 million tons annually), and
- 14% of potable water consumption, 15 trillion gallons per year.

USGBC.ORG

ENERGY USE

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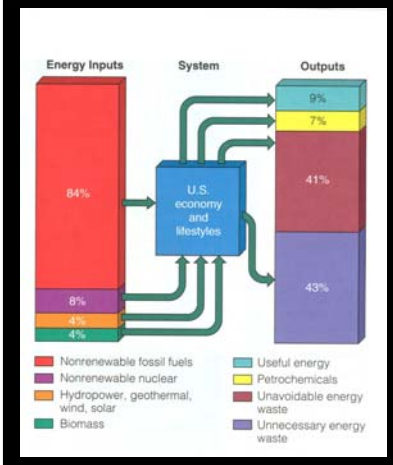

MILLER

MOTIVATION:

- ❑ Each energy production technique entails environmental consequences
- ❑ Fossil fuel use generates greenhouse gases

GOALS:

- ❑ Establish baseline energy efficiency and system performance
- ❑ Increase energy efficiency
- ❑ Encourage use of renewable and alternative energy sources
- ❑ Support Ozone protection protocols

USGBC.ORG

ENERGY USE

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WATER RESOURCES:

Statement of Energy Performance
FACILITY SUMMARY REPORT
Sample Facility

- DECISION-MAKING TOOLS:
  - FINANCIAL DECISION-MAKING
  - INTEGRATED DESIGN CHECKLIST
- RATING TOOLS:
  - LEED
  - GREEN GLOBES
  - GREENHOUSE GAS INVENTORY
- DESIGN TOOLS:
  - SCHEMATIC DESIGN TOOLS
  - DAYLIGHTING DESIGN TOOLS
  - ENERGY MODELING TOOLS

BENCHMARKING:

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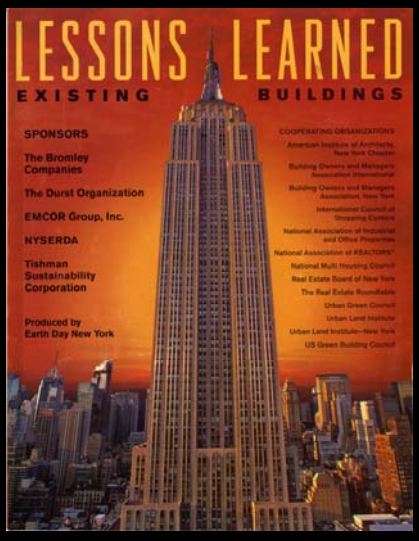

http://www.usgbc.org/
http://www.rmi.org/rmi/
http://www.eu-greenbuilding.org
http://www.esbsustainability.com

REFERENCES:

- DESIGN METHODOLOGY
  - IDENTIFY OPPORTUNITY
  - EVALUATE MEASURES
  - CREATE PACKAGES
  - MODEL ITERATIVELY

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1 Identify opportunities	2 Evaluate measures	3 Create packages	4 Model iteratively
• 60+ energy efficiency ideas were narrowed to 8 implementable projects	• Net present value	• Maximize net present value	• Iterative energy and financial modeling process to identify final eighht recommendations
• Team estimated theoretical minimum energy use	• Greenhouse gas savings	• Balance net present value and CO_2 savings	
• Developed eQUEST energy model	• Dollar to metric ton of carbon reduced	• Maximize CO_2 savings for a zero net present value	
	• Calculated for each measure	• Maximize CO_2 savings	

EMPIRE STATE BUILDING ENERGY PERFORMANCE, esbsustainability.com

DESIGN PROCESS:

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1. IDENTIFY OPPORTUNITIES:

- NATURAL SYSTEMS: Solar & Site
- PASSIVE SYSTEMS: Glazing, Insulation, Solar Shading, Architectural Daylighting, High Albedo Roofing
- ACTIVE SYSTEMS: Lighting, Mechanical, Controls, Photovoltaics
- NATURALLY INTEGRATED SYSTEMS: Green Roofs, Energy Recovery Systems, Ground Source Heat Pumps
- HUMAN FACTORS: Placemaking, Health, Well-Being, and Participation

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1. IDENTIFY OPPORTUNITIES:

- NATURAL SYSTEMS:

SOLAR RESOURCE

WATER RESOURCES

Every day more solar energy falls to the Earth than the total amount of energy the planet's 5.9 billion inhabitants would consume in 27 years (http://www.nrel.gov/documents/solar_energy.html.)

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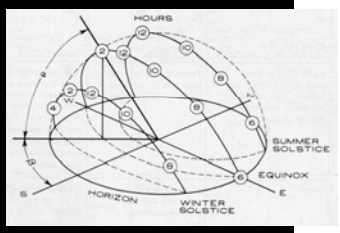
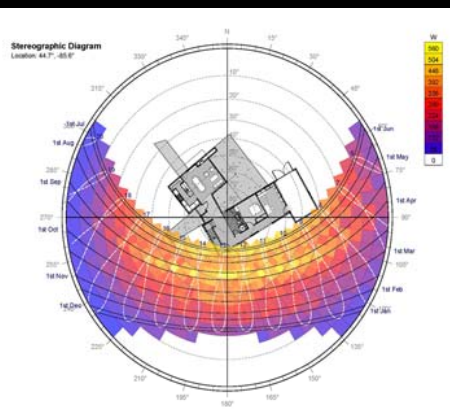
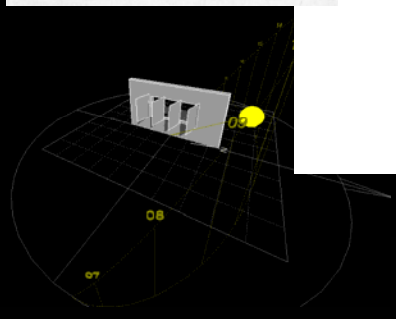
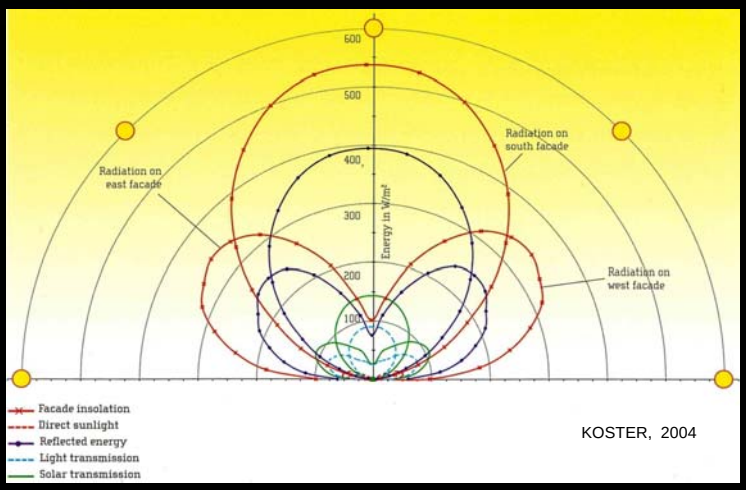






SOLAR PATH & INSOLATION



KOSTER, 2004

SOLAR INSOLATION: indicates the need for buildings to manage solar loads.

VARIABLE INSOLATION: indicates the need to respond to different loads on different facades.

OPPORTUNITIES:

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BEFORE

AFTER

ROCKY BRANCH CREEK, NCSU
NATURAL STORMWATER MANAGEMENT

NATURAL SYSTEMS

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1. IDENTIFY OPPORTUNITIES:

- PASSIVE SYSTEMS:
  - BUILDING ENVELOPE
  - SITE DESIGN

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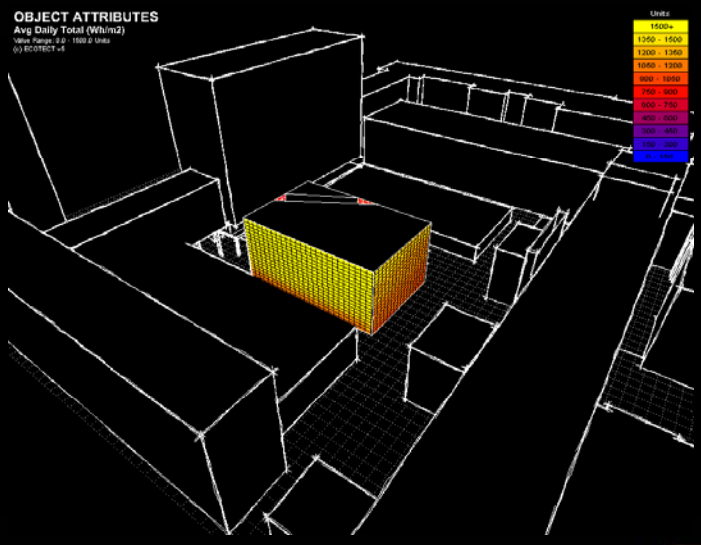
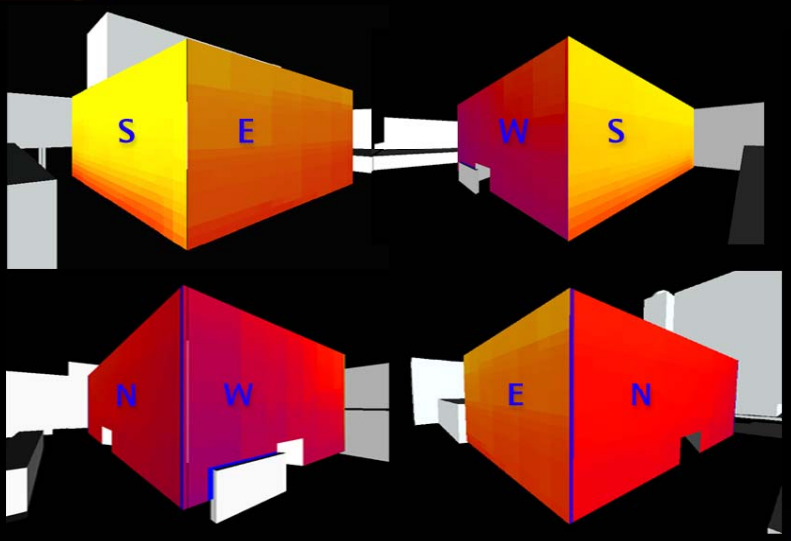


Incident Solar Radiation as a Design Tool

PASSIVE SYSTEMS:



Incident Solar Radiation as a Design Tool

PASSIVE SYSTEMS:

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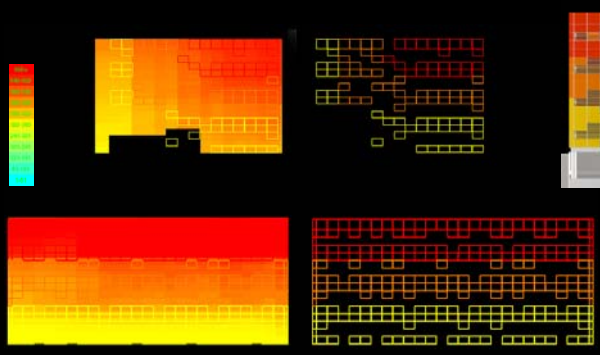
The effects of overshadowing by surrounding buildings on each façade was used to determine the most appropriate areas for the transparent and opaque fabric elements.

Insulated panel and window layouts were derived directly from this information.



PASSIVE SYSTEMS:

NC WILDLIFE BUILDING, NCSU CENTENNIAL CAMPUS

PASSIVE SYSTEMS:

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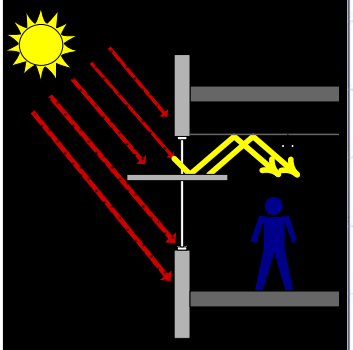
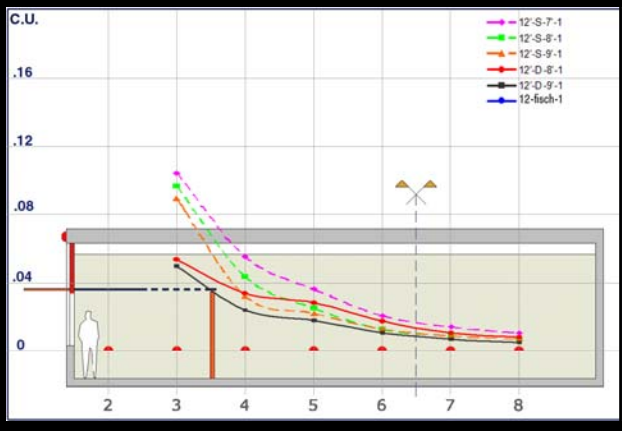
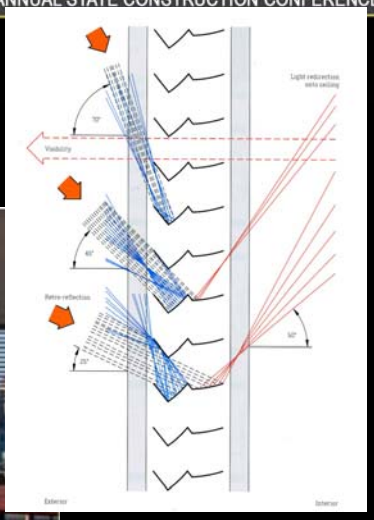
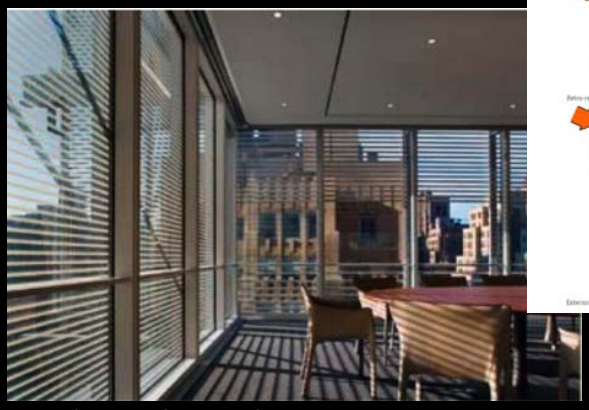




DR. PLACE, NCSU

PASSIVE SYSTEMS:





NEW YORK TIMES BUILDING

PASSIVE SYSTEMS:

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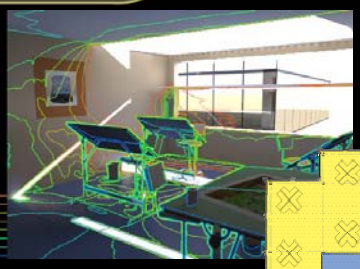
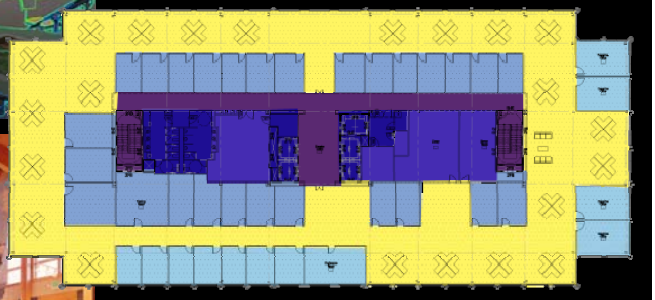
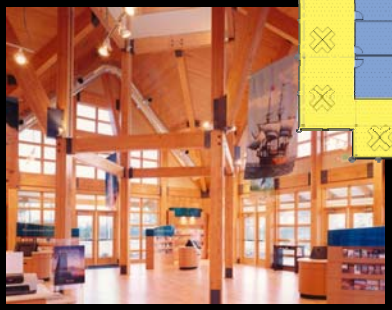


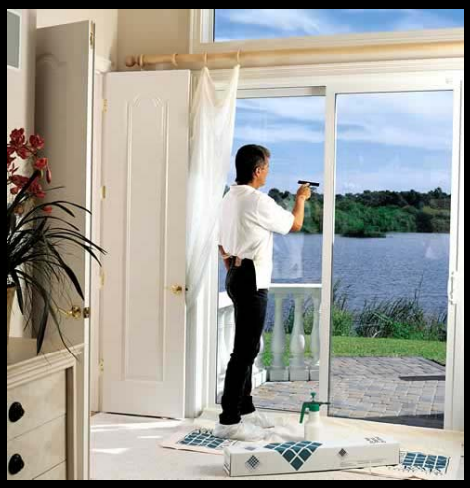
- **PROVIDE DAYLIGHT REDIRECTION AND/OR GLARE CONTROL FOR 75% OF ALL REGULARLY OCCUPIED SPACES.**





- **PROVIDE VIEWS FOR 75% OF ALL REGULARLY OCCUPIED SPACES.**

PASSIVE SYSTEMS:



ENERGY FILMS

MAGNETIC PANELS

PASSIVE SYSTEMS:

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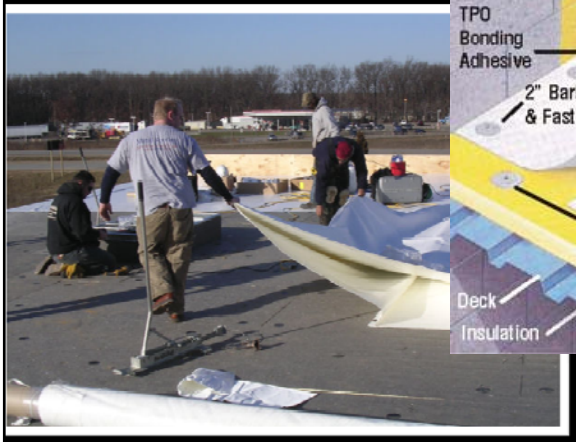
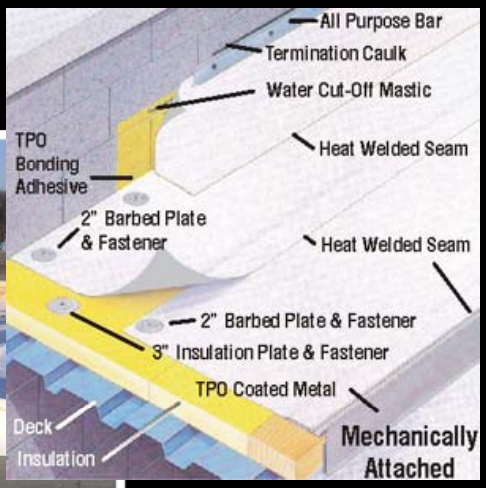
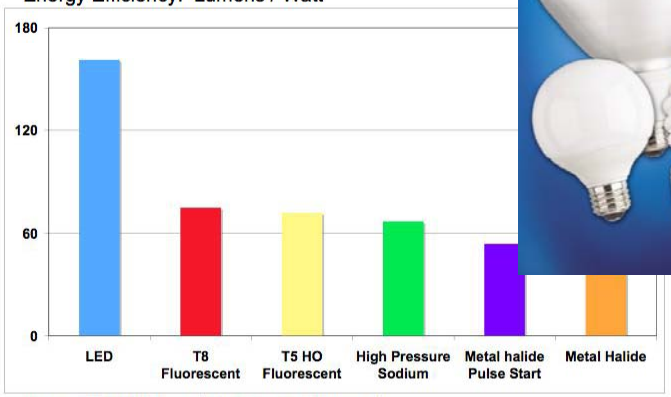




PASSIVE SYSTEMS:

Energy Efficient Lighting

Energy Efficiency: Lumens / Watt



Source Paragon Lighting and Green Econometrics research

Energy efficient lighting fixtures such as LED are provide twice the lumens per watt of electricity than legacy metal halide fixtures.

PASSIVE SYSTEMS:

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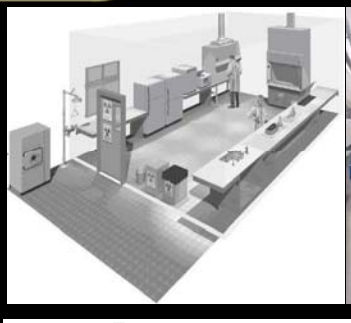

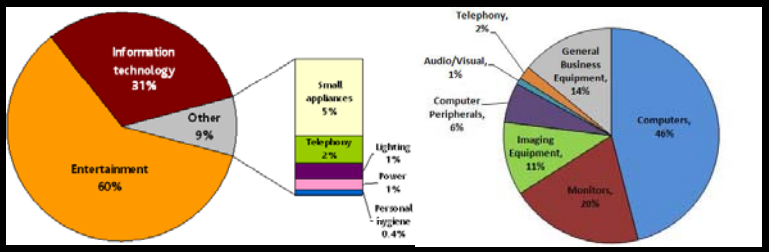

PASSIVE SYSTEMS:

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Water Efficiency Calculations

Fixture	Code GPM	Actual GPM	# Fixtures	Code Demand	Actual Demand
	From Table 604.4 (2006 NCPC)	Enter fixture gpm/gpf per mfg specs			
Toilet - Valve	3.50	1.60	10	35	16
Toilet - Tank	1.60	1.10	402	643	442
Urinal	1.00	0.50	2	2	1
Lavatory - Public	0.50	0.50	6	3	3
Lavatory - Private	2.20	1.00	402	884	402
Shower	2.50	1.50	402	1005	603
Kitchen Sink	2.20	2.20	298	656	656
Misc Fixtures	-	-			
a.				0	0
b.				0	0
c.				0	0
	Total Code Based Water Consumption			3228	
	Actual Water Consumption				2123

Percent Water Consumption Reduction **34.24%**

Fixtures:
Zurn Eco-Vantage Shower/Tub Valves (1.5 gpm)
Zurn Eco-Vantage 1.1 gpf Toilets
Sloan 1.6 gpf flush valves
Sloan .5 gpf urinal flush valves
1.0 gpm aerator on all lavatory faucets

Alternate:
Use full flow (2.5 gpm) shower head and install 1.0 gpm aerator on all Kitchen faucets (32.87% reduction)

PASSIVE SYSTEMS:

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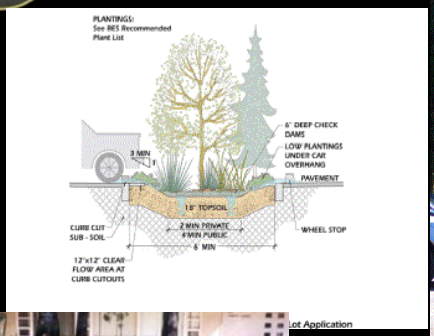
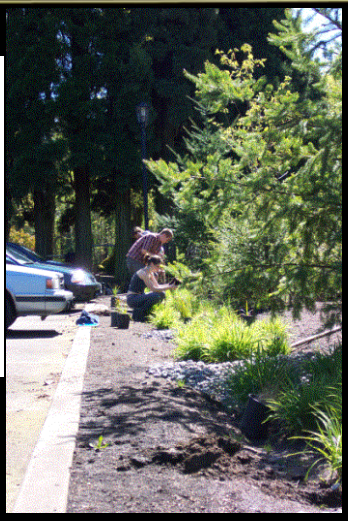


lot Application

RAIN
GARDEN



VEGETATED
SWALE

PASSIVE SYSTEMS:

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1. IDENTIFY OPPORTUNITIES:

- ACTIVE SYSTEMS:
  - PERFORMATIVE MEP SYSTEMS
  - RENEWABLE ENERGY
  - CONTROL SYSTEMS

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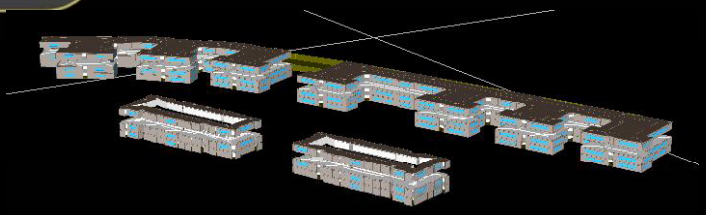

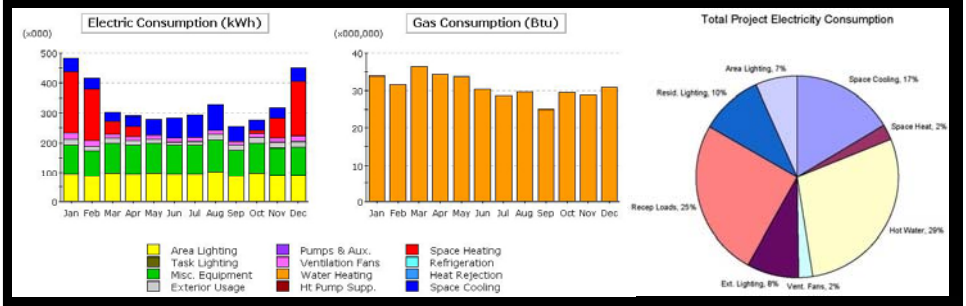

ACTIVE SYSTEMS:

Electric Consumption (kWhx000)	Scenario											
	Base	1	2	3	4	5	6	7	8	9	10	11
Space Cool	552	395	334	395	357	395	334	302	334	357	395	357
Space Heat	377	317	269	317	343	317	269	292	269	343	317	317
Hot Water	472	472	472	472	472	401	472	472	401	472	401	401
Ventilation Fans	209	161	161	161	153	161	161	153	161	153	161	153
Ext. Lighting	110	110	110	110	110	110	110	110	110	110	110	110
Recep. & Appliance Loads	753	753	753	649	753	753	649	753	753	649	649	753
Residential Lighting	416	416	416	416	208	416	416	208	416	208	416	208
General Lighting	142	140	140	140	140	140	140	140	140	140	140	140
Parking Deck Lighting	278	181	181	181	181	181	181	181	181	181	181	181
Parking Deck Vent.	87	43	43	43	43	43	43	43	43	43	43	43
Total	3395	2988	2880	2884	2760	2917	2775	2654	2809	2656	2813	2663
% Energy Savings	0.0%	12.0%	15.2%	15.1%	18.7%	14.1%	18.3%	21.8%	17.3%	21.8%	17.1%	21.6%
$ Energy Savings	$0	$35,829	$43,723	$43,444	$51,617	$41,060	$50,672	$57,962	$48,503	$57,832	$48,240	$57,433
LEED EA Credit 1 Points	0	1	2	2	3	2	3	4	2	4	2	4

1) Current Design
2) 15 Seer HVAC Units
3) Energy Star Refrig & Dishwasher
4) CF Lighting Program
5) Instantaneous Water Heaters
6) Scenario 2 & 3
7) Scenario 2 & 4
8) Scenario 2 & 5
9) Scenario 3 & 4
10) Scenario 3 & 5
11) Scenario 4 & 5

Scenario Descriptions

1) *Current design as shown on permit set of drawings*
2) *The use of 15 SEER split system HVAC units, as opposed to the use of more standard 13 SEER split system units.*
3) *Installing Energy Star rated refrigerators and dishwashers in all residential units. This scenario would also require a program be in place that would ensure all future replacement appliances would be of equal or better rating.*
4) *The use of Compact Fluorescent fixtures in all residential units.*
5) *The use of electric type instantaneous water heaters in all residential units.*

ACTIVE SYSTEMS:

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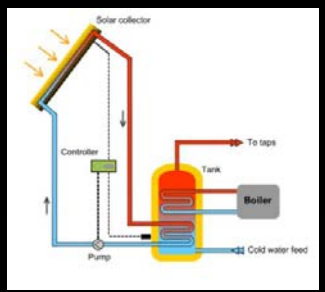
WIND TURBINES

SAS SOLAR ARRAY



SOLAR HOT WATER

ACTIVE SYSTEMS:

FRIEND'S CENTER, PHILADELPHIA, PA

ACTIVE SYSTEMS:

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FRIEND'S CENTER, PHILADELPHIA, PA

ACTIVE SYSTEMS:

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1. IDENTIFY OPPORTUNITIES:

- NATURALLY INTEGRATED SYSTEMS:
  - ENERGY RECOVERY
  - GROUND SOURCE HEAT PUMPS
  - GREEN ROOFS

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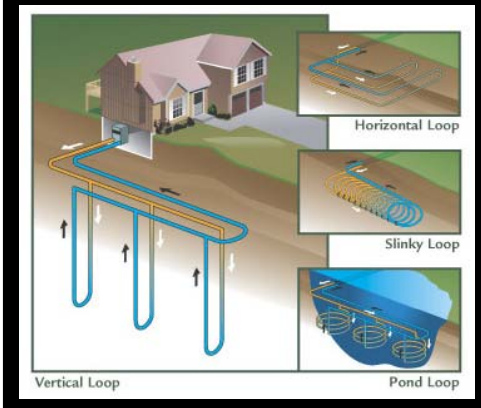
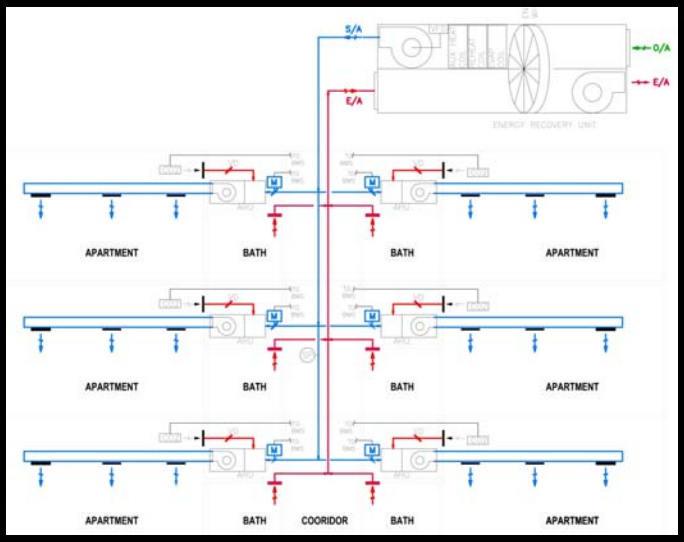


NATURALLY INTEGRATED SYSTEMS



NATURALLY INTEGRATED SYSTEMS

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CHICAGO CITY HALL

NATURALLY INTEGRATED SYSTEMS

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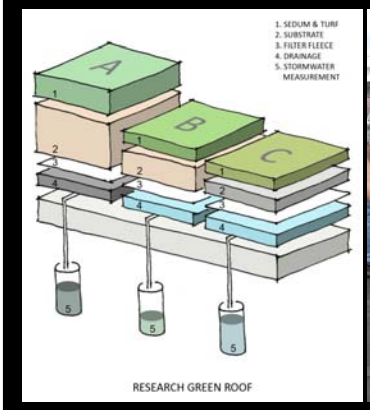

WEST VILLAGE, DURHAM, NC

NATURALLY INTEGRATED SYSTEMS

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1. IDENTIFY OPPORTUNITIES:

- HUMAN FACTORS:

  PARTICIPATORY DESIGN & ENGAGEMENT

  PLACEMAKING

  HEALTH, WELL-BEING & PERFORMANCE

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HUMAN FACTORS:

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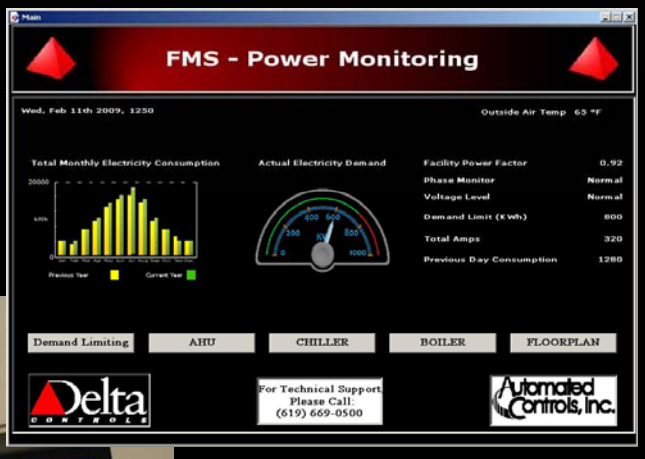

HUMAN FACTORS:

LESSONS LEARNED / OBSERVATIONS:

- THINK NATURAL SOLUTIONS FIRST
- CONSERVATION = EFFICIENCY
- CLIP THE PEAK LOADS TO REDUCE DEMAND
- LOOK AT PRIMARY AND SECONDARY ENERGY
- DEMONSTRATION PROJECTS FOR RENEWABLES
- IT'S NOT ALL ABOUT ENERGY PERFORMANCE

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- CASE STUDY: WOODSIDE MILL COMPLEX

FORMERLY THE WORLD'S LARGEST COTTON MILL
APPROXIMATELY 600,000 SF
ADAPTIVE REUSE OF 8 HISTORIC STRUCTURES
PROJECTED LEED V3 GOLD

WOODSIDE MILL COMPLEX CASE STUDY:

WOODSIDE MILL COMPLEX CASE STUDY:

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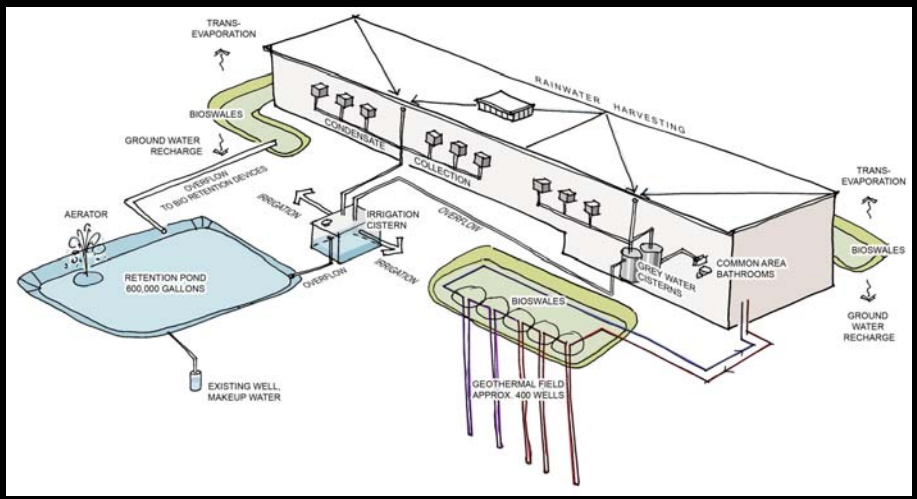
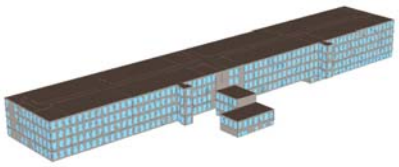


WOODSIDE MILL COMPLEX CASE STUDY:

JDAVISARCHITECTS

Woodside Mill, Greenville, South Carolina
Building Energy Model



SECTION 2 – Integrated Des v. Developer Std

Utilities
- Electric: 0.0718 $/kWh
- Gas: 1.498 $/therm

DEVELOPER STANDARD BUILDING

Internal Loads

Space Classification	Lights, W/sf	Equipment, W/sf	Occupancy, sf/pers
Office	1.1	0.5	200
Corridor	0.5	0	1000
Lobby	1.3	0.38	100
Restrooms	0.9	0.15	300
Apartment	0.7	*see below	300
Fitness/Exercise	0.5	0.1	50
Mech/Elec Room	1.5	0.1	2000

- Lighting equal to ASHRAE 90.1-2004 maximum values
- Equipment per estimated plug loads
- Occupancy per estimated load based on zone classification
- Apartment Plug Loads:
  - Electric: Cooking – 0.48 W / sf; Refrigerator – 0.25 W/sf, Plug Loads – 0.5 W/sf
  - Gas: Laundry – 816 kWh / year / apartment
- Exterior Lighting – 10 kW
- Daylighting: None
- External Shades – none

Results

Electricity (kWhx1000)	Dev Std	cost	Integ Des	cost
Space Cool	739.4	$ 74,458	549.5	$ 55,335
Space Heat	191.6	$ 19,294	82.5	$ 8,308
HP supp.	87.4	$ 8,801		$ -
Vent Fans	1413.8	$ 142,370	921.3	$ 92,775
Pumps	7.7	$ 775	168	$ 16,918
Hot Water	149.7	$ 15,075	34.93	$ 3,517
Ext. Usage	34.7	$ 3,494	34.7	$ 3,494
Misc. Equip	1342.2	$ 135,160	1342.2	$ 135,160
Lights	775	$ 78,043	660.4	$ 66,502
Total	**4,741.5**	**$ 477,469**	**3,793.5**	**$ 382,008**
Natural Gas (Mbtu)				
Space Heat	199.5	$ 2,989		$ -
Total	**199.5**	**$ 2,989**	**0.0**	**$ -**
Annual Cost	$ 480,458		$ 382,008	
Cost Savings		20.5%	$ 98,449	
Electric Savings (kWh)			947,970	
Gas Savings (MBTU)			199.5	
GHG Savings (lb CO2e)			972,109.5	
Annual Cost HVAC	$ 248,686		$ 173,335	
Savings HVAC only		30.3%	$ 75,352	

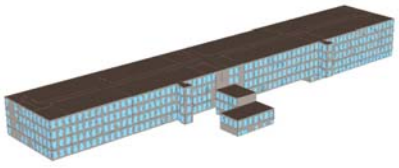
Greenhouse Gas Emissions Savings are based on *Source Energy and Emission Factors for Energy Use in Buildings*. Technical Report No. NREL/TP-550-38617. M. Deru and P. Torcellini. National Renewable Energy Laboratory: Golden, CO. June 2007.
Factors based on Delivered Electricity for South Carolina and On-site Combustion of Natural Gas in a furnace.
Units are lbs of Carbon Dioxide Equivalent.

WOODSIDE MILL COMPLEX CASE STUDY: Energy

THE 29TH ANNUAL STATE CONSTRUCTION CONFERENCE

JDAVISARCHITECTS

Woodside Mill, Greenville, South Carolina
Building Energy Model



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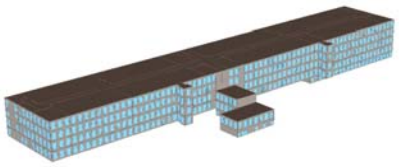
486 TONS ANNUAL CO2 SAVINGS

WOODSIDE MILL COMPLEX CASE STUDY: Energy

Woodside Mill, Greenville, South Carolina
Building Energy Model



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486 TONS ANNUAL CO2 SAVINGS

30.3% TOTAL ENERGY SAVINGS

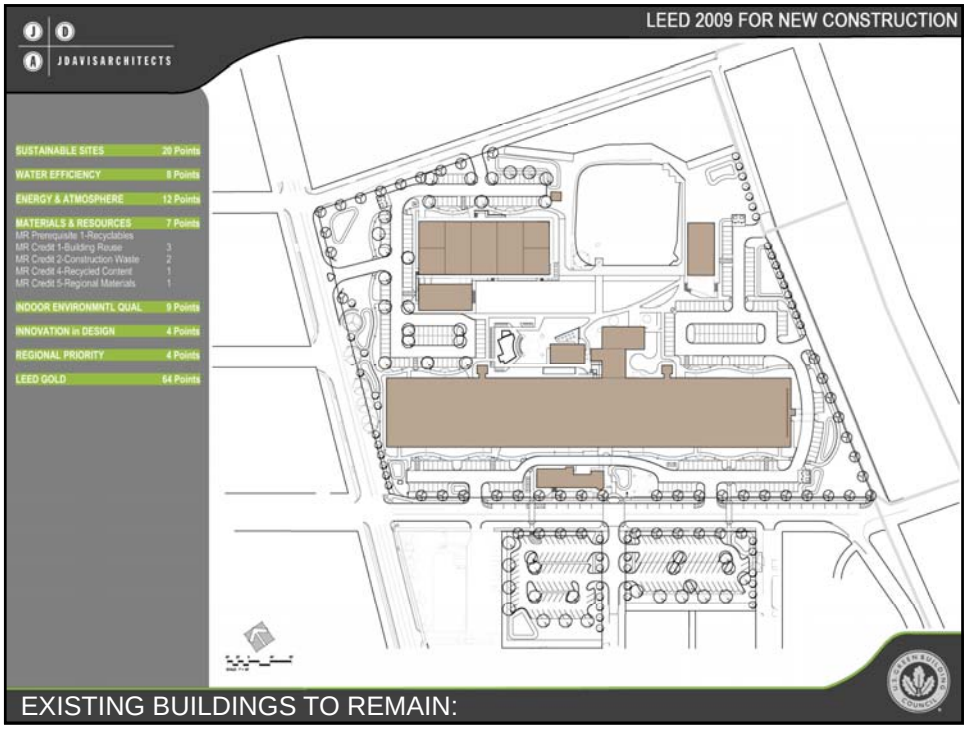
WOODSIDE MILL COMPLEX CASE STUDY:

JDAVISARCHITECTS
THE 29TH ANNUAL STATE CONSTRUCTION CONFERENCE

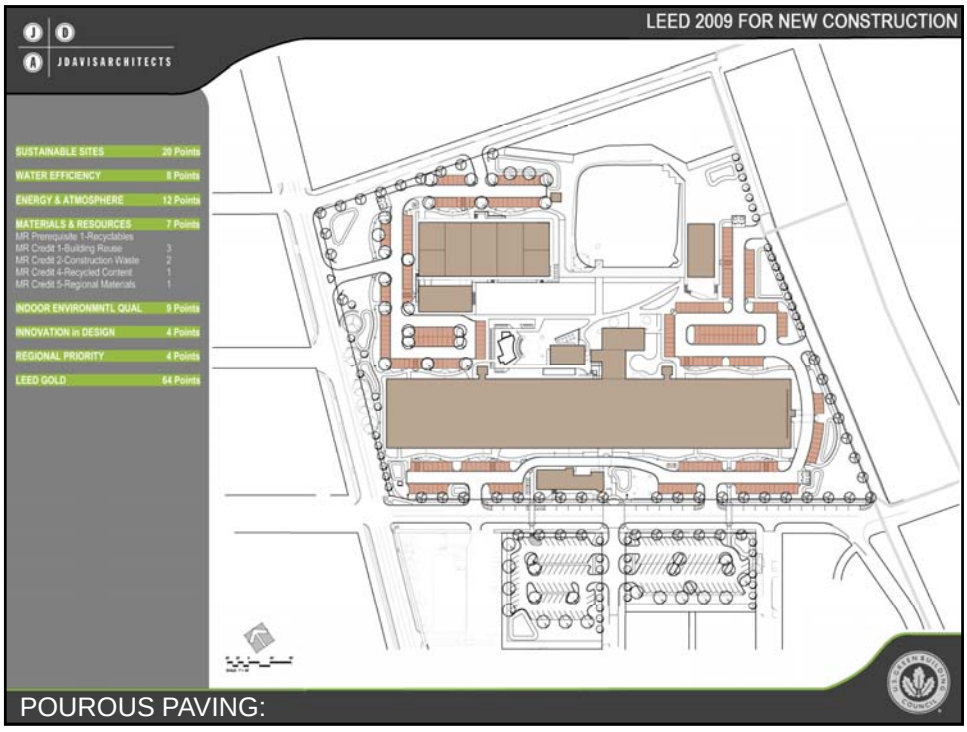
SUSTAINABLE SITES	20 Points
WATER EFFICIENCY	8 Points
ENERGY & ATMOSPHERE	12 Points
MATERIALS & RESOURCES	7 Points
INDOOR ENVIRONMNTL QUAL	9 Points
INNOVATION in DESIGN	4 Points
REGIONAL PRIORITY	4 Points
LEED GOLD	64 Points

SITE PLAN

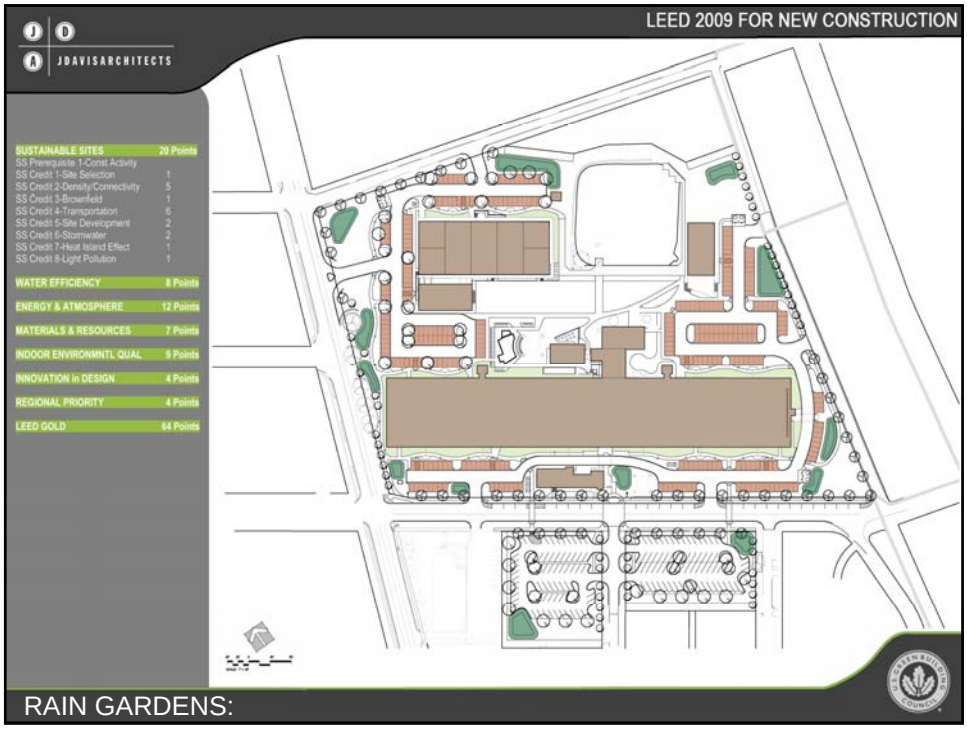
WOODSIDE MILL COMPLEX CASE STUDY:



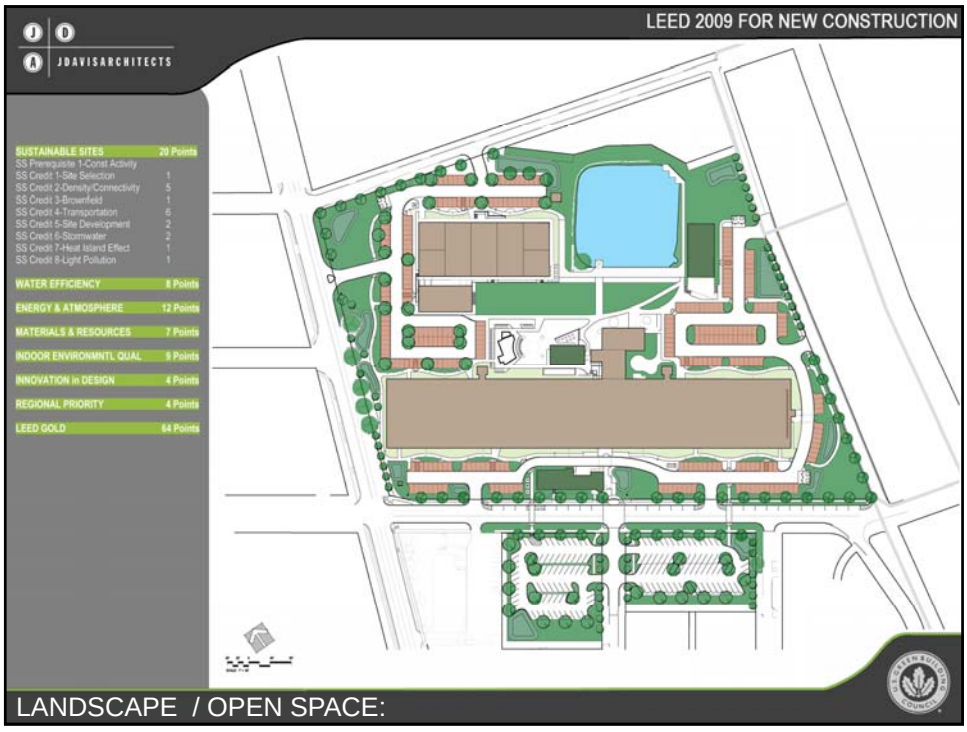
EXISTING BUILDINGS TO REMAIN:



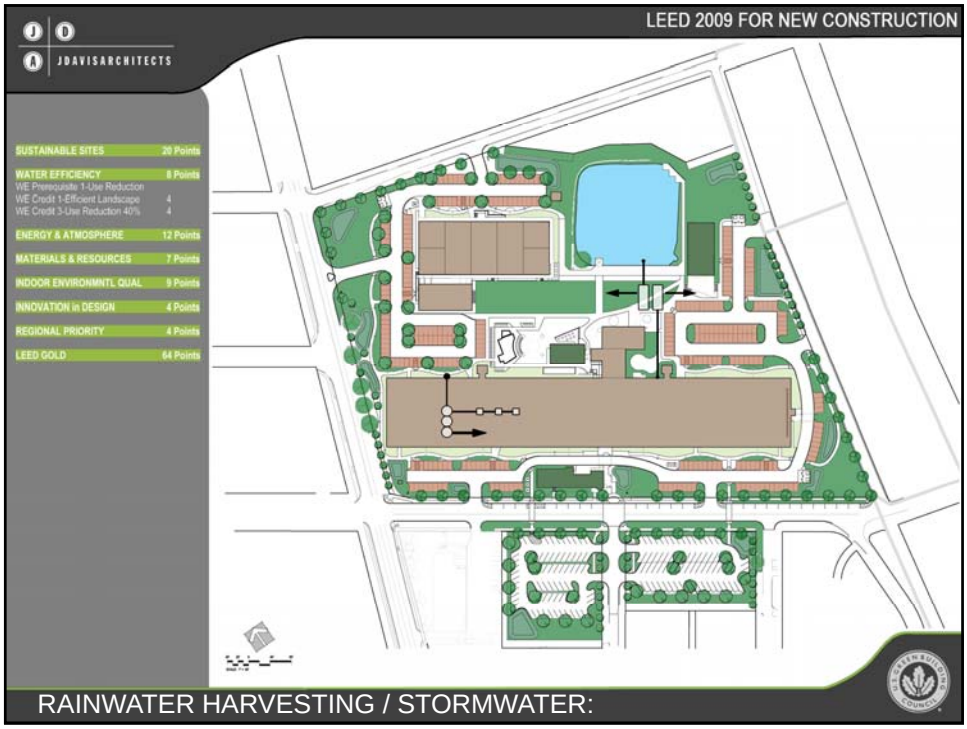
POUROUS PAVING:

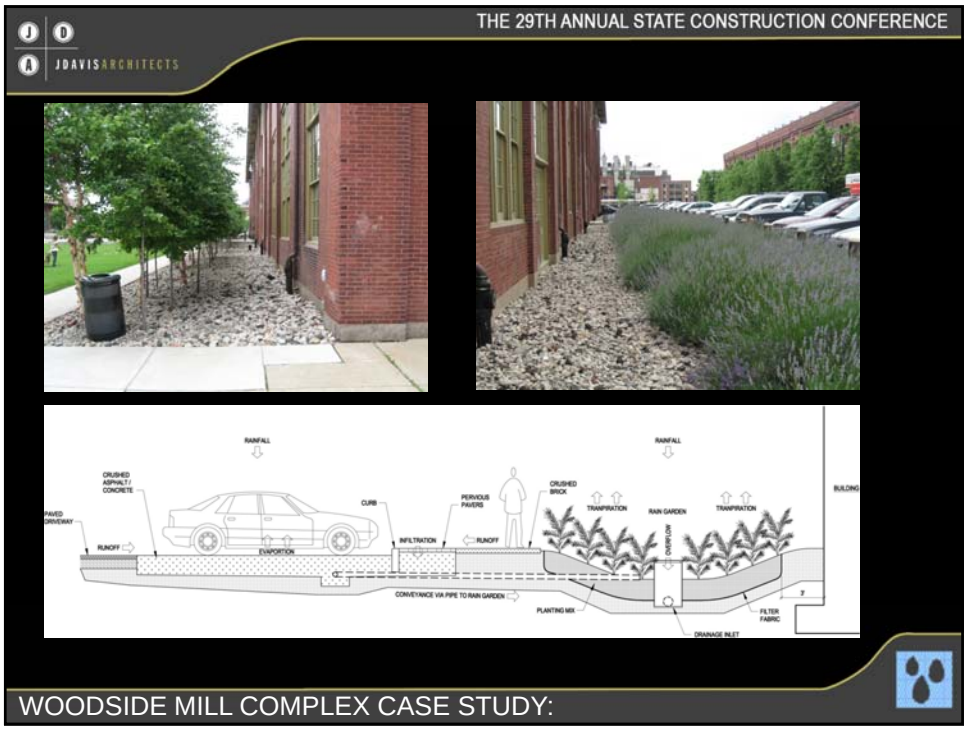


RAIN GARDENS:



LANDSCAPE / OPEN SPACE:


JDAVISARCHITECTS
LEED 2009 FOR NEW CONSTRUCTION
SUSTAINABLE SITES 20 Points
WATER EFFICIENCY 8 Points
WE Prerequisite 1-Use Reduction
WE Credit 1-Efficient Landscape 4
WE Credit 3-Use Reduction 40% 4
ENERGY & ATMOSPHERE 12 Points
MATERIALS & RESOURCES 7 Points
INDOOR ENVIRONMNTL QUAL 9 Points
INNOVATION in DESIGN 4 Points
REGIONAL PRIORITY 4 Points
LEED GOLD 64 Points
RAINWATER HARVESTING / STORMWATER: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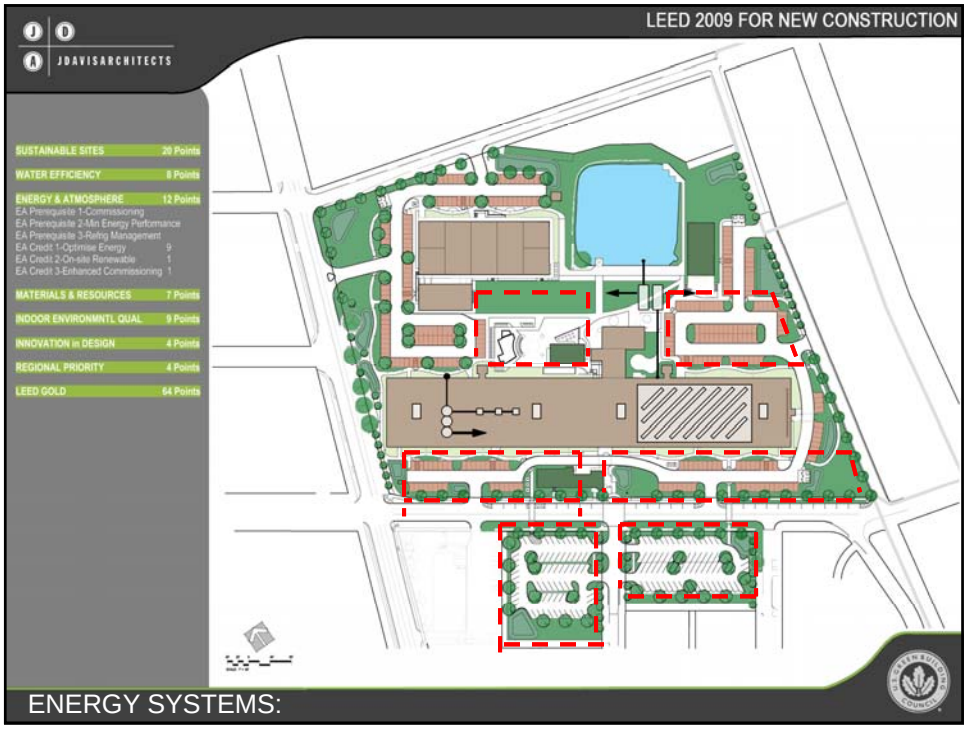
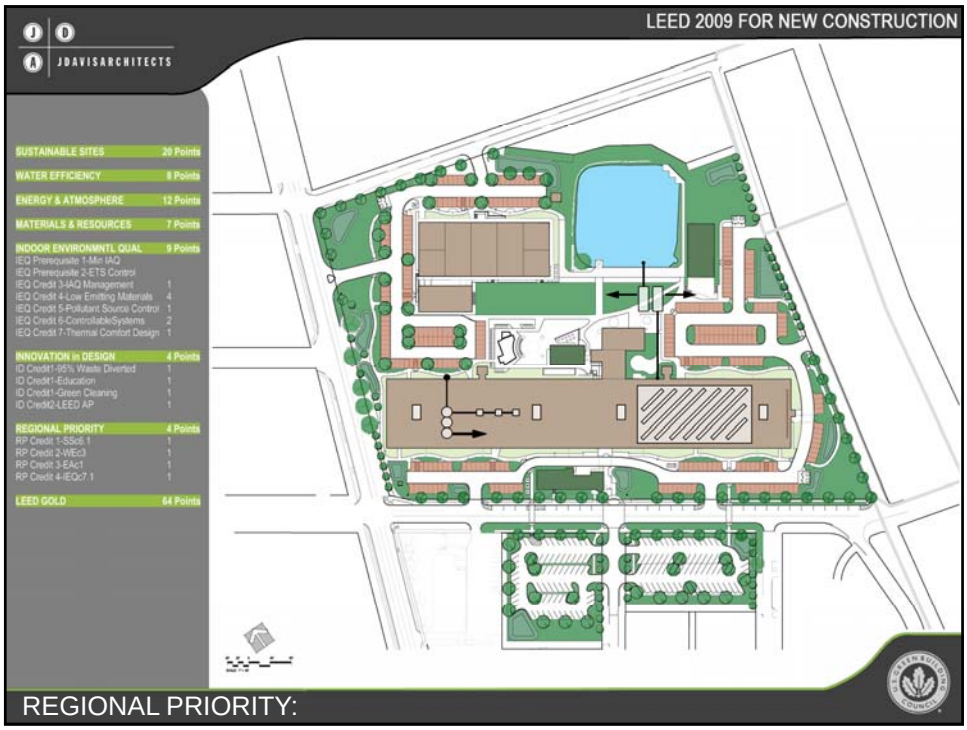
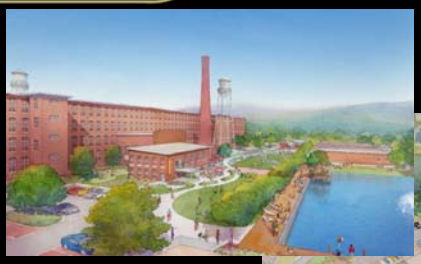
RAINFALL
RAINFALL
CRUSHED ASPHALT / CONCRETE
CURB
PERVIOUS PAVERS
CRUSHED BRICK
TRANSPIRATION
RAIN GARDEN
TRANSPIRATION
BUILDING
PAVED DRIVEWAY
RUNOFF
EVAPORTION
INFILTRATION
RUNOFF
OVERFLOW
CONVEYANCE VIA PIPE TO RAIN GARDEN
PLANTING MIX
FILTER FABRIC
DRAINAGE INLET
WOODSIDE MILL COMPLEX CASE STUDY:



ENERGY SYSTEMS:



REGIONAL PRIORITY:



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QUESTIONS:

K. Daryl Carrington, Ph.D., AIA, LEED AP+Homes