Worcester North High School

Worcester North High School

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2010 AE | CM

Worcester North High School

Project At A Glance

Location: Worcester, Massachusetts

Size: 195,000 Square-Foot Educational Facility

Replacing Existing 75,000 SF Building

1,200 Students

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Project At A Glance

Guaranteed Maximum Price: $54 Million

Duration: 29 Months

April 2009 – September 2011

CM-at-Risk: Gilbane Building Co.

Gilbane

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Overview: Thesis Efforts

Common Thread: Sustainability

How can this building's efficiency be improved?

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How can this building's efficiency be improved?

Analyses:

I. CHPS Rating (Collaborative for High-Performance Schools)

COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS
CHPS

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Overview: Thesis Efforts

Common Thread: Sustainability

How can this building's efficiency be improved?

Analyses:

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II. Green Roof

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III. Solar PV System

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I. CHPS Rating (Collaborative for High-Performance Schools)

II. Green Roof

III. Solar PV System

IV. LED Luminaire Implementation

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CHPS Study: Probing Questions

How do CHPS and/or LEED affect the construction industry and building process?

What can be done to improve the quality and efficiency of the rating system?

COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS
CHPS

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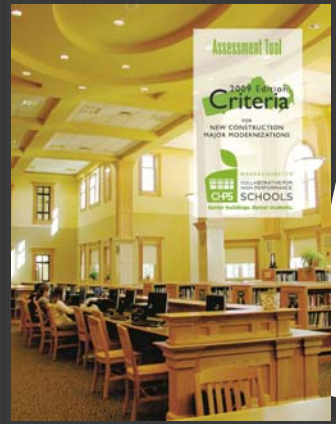
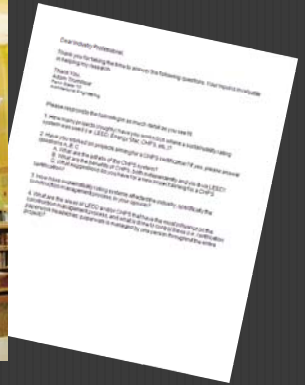
CHPS Study: Research Methods

- Personal review of the rating system
- Surveys of professionals





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CHPS Study: Background

- Established in California, 1999
- Region-specific programs in 11 states

  CA, WA, NY, MA, ME, NH, VT, CT, RI, CO, TX
- Over 225 organizations are currently members

  (Schools, Utilities, Design firms, etc.)

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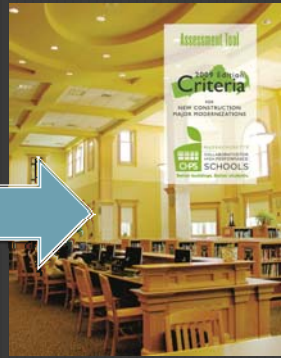
CHPS Study: Background

Massachusetts:

- Version 1.0 in 2006
- Version 2009 second and current version
- Standard for all new schools in Massachusetts
- 23 Prerequisite credits
- 125 possible points:
  - + Minimum of 40 points to be “Verified”
  - + Minimum of 50 points to be “Verified Leader”



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Category	ID	Title
STRATEGY		Integration and Innovation
	II.P1	Integrated Design
	II.P2	Educational Display
DESIGN		Indoor Environmental Quality
	EQ.P1	HVAC Design - ASHRAE 62.1
	EQ.P2	Construction IAQ Management
	EQ.P3	Pollutant and Chemical Source Control
	EQ.P4	Moisture Management
	EQ.P5	Minimum Filtration
	EQ.P6	Thermal Comfort - ASHRAE 55
	EQ.P7	View Windows, 70%
	EQ.P8	Eliminate Glare
	EQ.P9	Minimum Acoustical Performance
	EQ.P10	Minimum Low Emitting Materials
		Energy
	EE.P1	Minimum Energy Performance, 20%
	EE.P2	Commissioning
	EE.P3	Facility Staff & Occupant Training
		Water
	WE.P1	Irrigation System Performance on Recreational Fields
	WE.P2	Indoor Water Use Reduction, 20%
		Site
	SS.P1	Joint Use of Facilities and Parks
		Materials & Waste Management
	MW.P1	Storage and Collection of Recyclables
	MW.P2	Minimum Construction Site Waste Management, 75%
PERFORMANCE		Operations and Maintenance
	OM.P1	Maintenance Plan
	OM.P2	Anti-Idling Measures
	OM.P3	Green Cleaning

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CHPS Study: Findings

- LEED difficult on limited budgets
- Closer relationships: CM, Designers, Owner
- CHPS is a smaller organization than LEED
- Need for lessons learned database
- No drastic change to CM by CHPS
- North High School will be CHPS Verified

U.S. GREEN BUILDING COUNCIL LEED USGBC

CHPS COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS

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CHPS Study: Recommendations

- CHPS is better for MA schools than LEED
- Need for training professionals in CHPS
- Create lessons-learned database for CHPS projects
- Increase capabilities of regional offices
- Glean input from students and administration

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Green Roof Study: Intent

Evaluate the implementation of a green roof on North High school, considering structural effects.

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Green Roof Study: Background

- Reduced storm water runoff
- Reduced heat-island effects
- Increased aesthetic quality
- Increased life of roof membrane
- Incremental addition to roof R-value
- Possible addition to CHPS score

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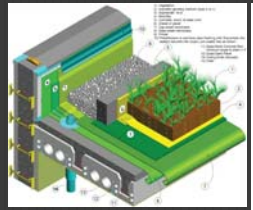
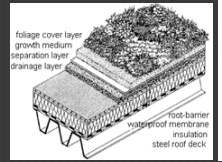
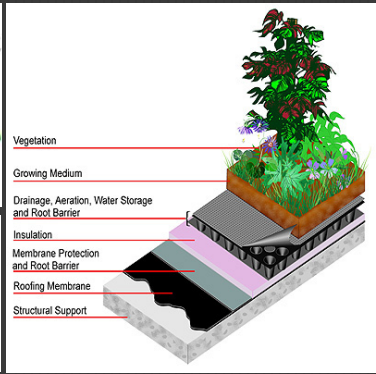
Green Roof Study: Analysis Method

1. **Research available green roof systems**
2. Assemble weight data
3. Choose most economical option
4. Evaluate structural capacity







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Manufacturer	Size	Soil Depth	Saturated Weight
Roofscapes Roofmeadow	No module size (mat-type)	3" – 5"	20 – 34 PSF
ZinCo	No module size (mat-type)	4.5"	22 PSF
Hydrotech USA	No module size (mat-type)	2" – 6"	17 – 41 PSF
GreenGrid	2' x 2', 2' x 4', 1.5' x 2'	4"	18 – 25 PSF
LiveRoof	1' x 2'	4" – 4.25"	15 – 29 PSF
Barrett Company	No module size (mat-type)		21 PSF

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1. Research available green roof systems
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4. **Evaluate structural capacity**

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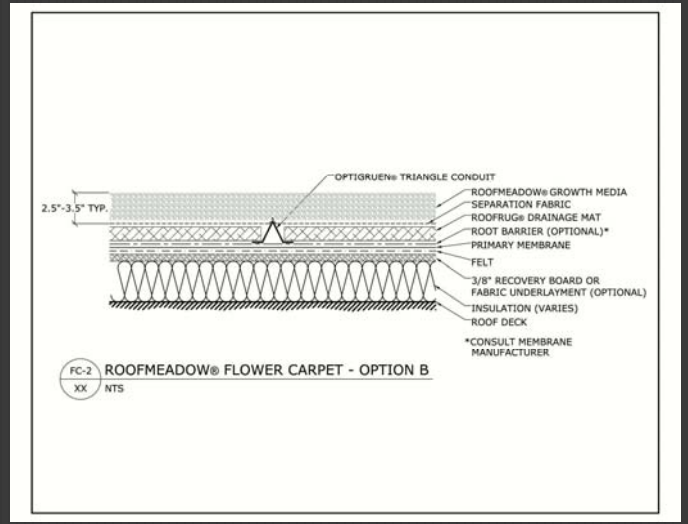
Green Roof Study: Findings

- Extensive roof appropriate option
- Minimum 15 PSF, Maximum 41 PSF
- Use 3" system with 23 PSF rating
- Maximum area is 51,000 SF
- Maximum moment, shear and deflection within allowable limits
- Added cost: $522,750
- No schedule delay; not on critical path



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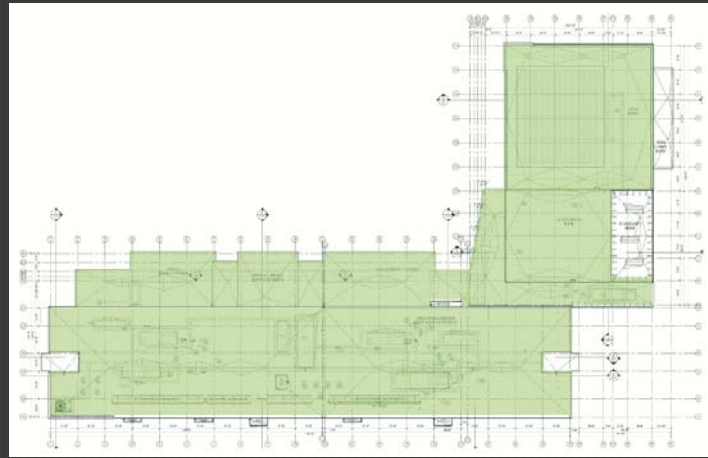
Green Roof Study: Recommendation

- Install green roof
- Use Roofscapes™ assembly: Primarily sedum
- 51,000 square-feet will cost $522,750
- Cost may be recouped after 50 year maintenance is deferred
- 1 Point addition to CHPS score



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Solar PV: Intent

Design a roof mounted solar photovoltaic system,

meeting the given $250,000 allowance.

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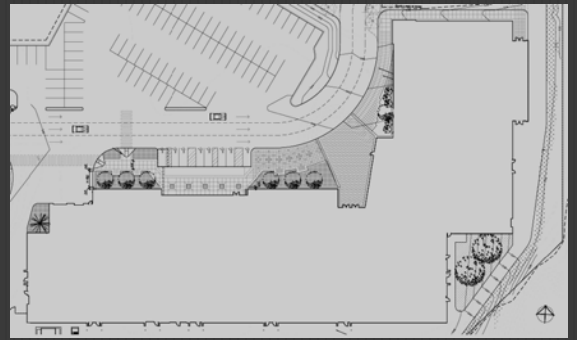
Solar PV: Background

- $250,000 allowance in budget, unused
- System has the ability to provide sustainable power to North High School
- Potential credit to CHPS score
- System design is project-specific



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Solar PV: Method

1. **Research system types and components, costs**
2. Design 2 options:
   - Meet full $250,000 allowance
   - Fill allotted roof space
3. Calculate Payback

Source	Cost per Watt
Estimation Cost Data	
RSMeans 2009 Cost Data	$11.70
Newspaper Articles	
Alteris Renewables	$5.87
Ostrow Electric	$5.39
Fall River Electrical Associates	$4.72
Waterline Industries, Corp.	$5.86
Online Estimation Tools	
BP Solar Estimator:	$6.00
Solar-Estimate.org:	$6.03
Cold Calls	
Zapotec Solar	$8.00

Source	Average Cost per Watt
Newspaper Articles	$5.46
Online Estimates	$6.02
Cold Call	$8.00
Total Average:	**$5.98**

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Solar PV: Method

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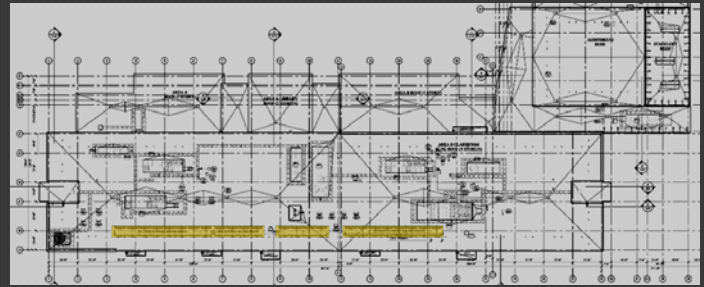

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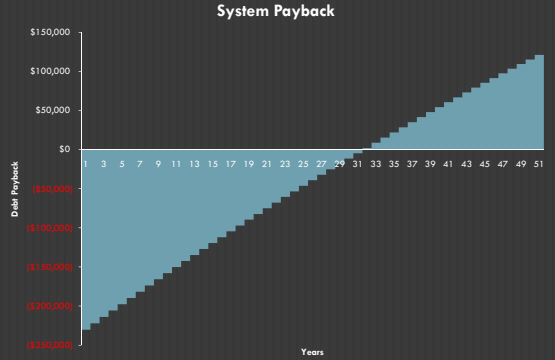

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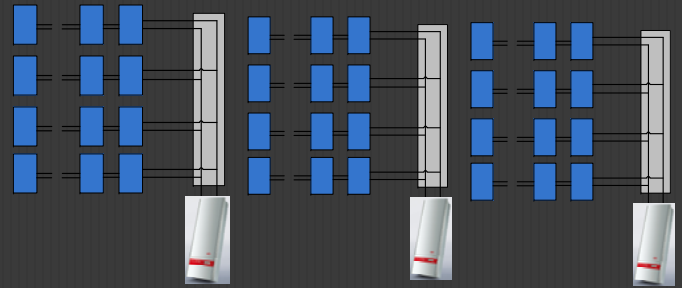
Solar PV: $250,000 System

Maximum Power: 38,640 Watts (38.64 kW)

(3) 12.88kW arrays comprise the 38.64 kW system:

Solar Panels:	(56) BP Solar 3230T, 230W each
Inverter:	(1) Fronius IG Plus, 13.8 kW
Combiner Box:	(1) SMA SBCB-6
Wiring:	(4) Strings in Parallel (1) string = 14 panels in series
Area Required:	3,000 Square Feet



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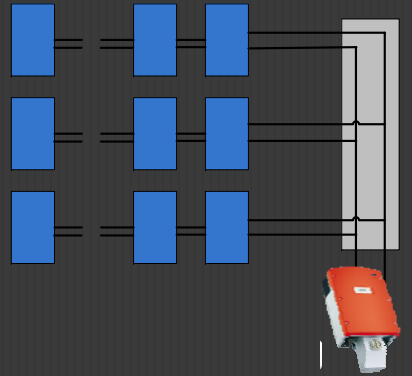
Solar PV: 6,000 SF of Roof Space

Maximum Power:	7,590 Watts (7.59 kW)
Solar Panels:	(33) BP Solar 3230T, 230W each
Inverter:	(1) SMA Sunny Boy SB7000US, 8.75 kW
Combiner Box:	(1) SMA SBCB-6
Wiring :	(3) Strings in Parallel (1) String = 11 panels wired in series
Area Required:	592.68 Square Feet



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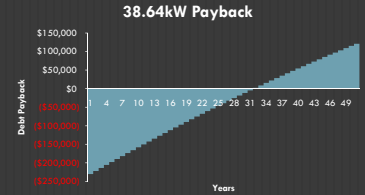
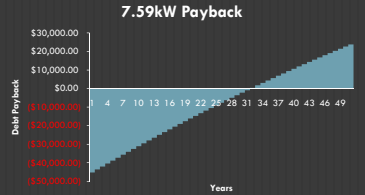
Solar PV: Recommendation

- Both systems show a payback of 31 years (cash financing)
- Implement smaller array to reduce structural impact
- Implement larger array if funds are available and gymnasium can support array
- Up to 5 credits added by PV system





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LED Luminaires: Intent

Investigate the application of LED luminaires as part of the general illumination scheme.

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LED Luminaires: Background

- Useful in down, accent and track lighting
- Low lumen/watt rating
- Color temperature tends to be cool
- Ballast often integrated with lamp: replacement?
- High initial cost

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LED Luminaires: Method

1. **Literature research**
2. Product search
3. Compute/Model illumination
4. Analyze
5. Recommendation

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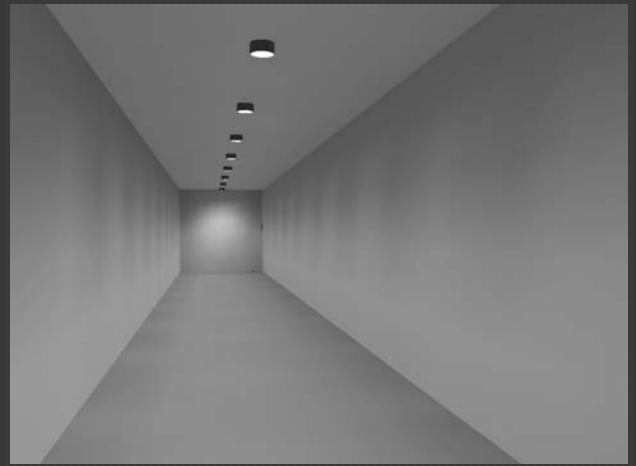

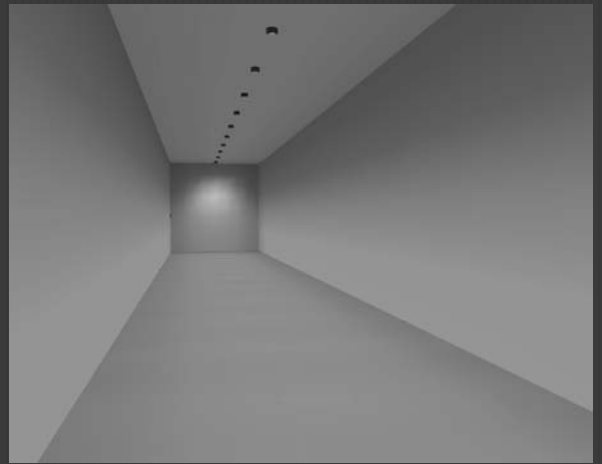

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LED Luminaires: Method

1. Literature research
2. Product search
3. Compute/Model illumination
4. **Analyze efficiency, cost, payback**
5. Recommendation

Luminaire	Lamp Type	Watts	Cost	Design Life Hrs	Cost per kWh	Cost for 50k Hours	Cost for 15 fc over 50k hours	
AF 1/32TRT 277	CFL	32	$200	12000	0.172	$525.20	$4,726.80	(Req's 9 Luminaires)
LR6-DR1000 277V	LED	12.5	$450	50000	0.172	$557.50	$7,805.00	(Req's 14 Luminaires)

# Lamps required for 50k hours	Min # Lamps for 50k hours	Cost per Lamp	Relamp Cost Over 50k Hours
4.166667	5	$10	$50

Table IV.2 Life cycle cost analysis of LED v. CFL over life of lamp.

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LED Luminaires: Recommendation

- Not ready for general illumination
- Downlighting an option
- Life-cycle cost too high to justify
- LED technology not ready for North High School

Replacing 125 CFLs = 186 LEDs

Energy reduced from 3968 to 2325 watts

$3,696 in annual energy savings

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CHPS
- Good regional system for schools
- Needs improvement in knowledge transfer

Green Roof
- Feasible with current roof and 23 PSF assembly
- Cost: $ 522,750
- Could pay itself back in 50 years

Solar PV System
- Two options for owner
- Both pay back after 31 years
- Acts as a learning tool for students

•LED Luminaires
- More energy efficient
- Life-cycle cost not competitive
- Technology forthcoming

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Lessons Learned

- Good input is hard to get!
- More research is needed on the effects of sustainability ratings on the construction management process.
- “Greening” a typical building produces large benefits; making a green building greener presents incremental benefits .
- Payback is not as immediate as you’d think.
- Great learning experience.

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Questions?