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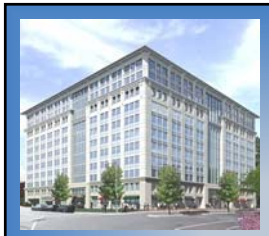

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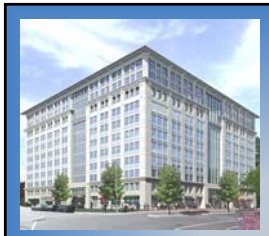
- Project Overview
- Current LEED Status
- LEED Accreditation Owner Assessment
- Glazing Alternative Analysis
- Green Roof Addition Analysis
- Potential Financial and LEED Status
- Questions



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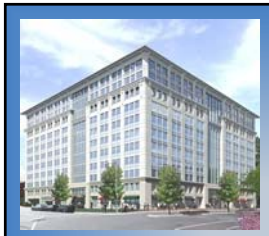
Function:	Mixed Office & Retail
Size:	344,000 SF
Levels:	3 Below Grade, 11 Above
Construction Schedule:	Nov. 2006 – Sept. 2008
Construction Cost:	$41,000,000
Delivery Method:	Design-Bid-Build
Contractual Arrangement:	Cost Plus Fee with a GMP



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PROJECT TEAM

Owner,

50% Joint Venture

Brookfield Properties

Brookfield Properties

ING REAL ESTATE

ING Clarion

Architect

dcs DESIGN

Davis, Carter, Scott

General Contractor

DAVIS

James G. Davis Construction Corporation

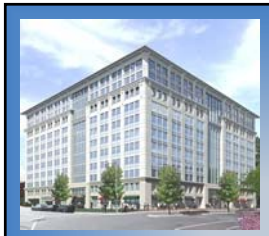
Structural Engineer

Fernandez and Associates

MEP Engineer

GIRARD ENGINEERING

Girard Engineering



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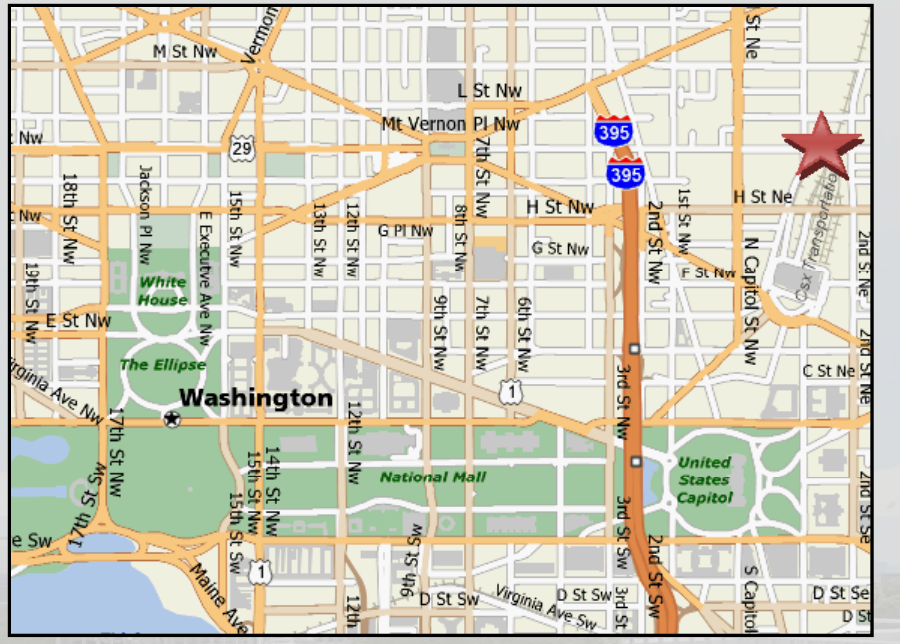
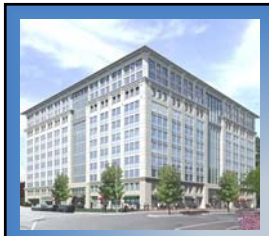


- Less than a half mile north of Union Station (train station)
- One mile northeast of the United States Capitol Building
- Numerous public transportation routes within close proximity
- North of Massachusetts (NoMa) development district



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Structural System:

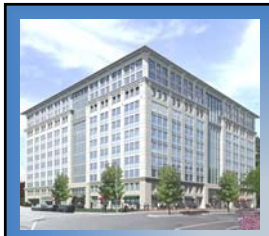
- 4,000 psi, 4’-0” thick mat foundation
- Below Grade: 9” reinforced flat slab
- Above Grade: 10”-11” post-tensioned two-way slab

Façade:

- Glass curtainwall
- Insulating vision glass
- Precast concrete panels
- EIFS system at roof penthouse

Mechanical System:

- (3) Rooftop cooling towers
- Self-contained units at each typical floor
- Limited number of VAV boxes in tenant spaces



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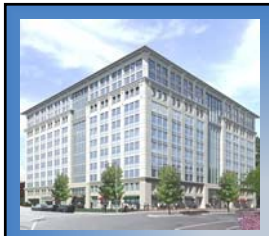
LEED for Core & Shell Development

- LEED certification considered late in project planning
- LEED benchmark survey performed
- Fell short of *Energy & Atmosphere Prerequisite Credit 2*
    - Only achieved 4.8% energy savings
    - Significantly shy of 14% requirement
- Would require mechanical redesign and mechanical equipment had already been ordered
- Idea of LEED accreditation abandoned



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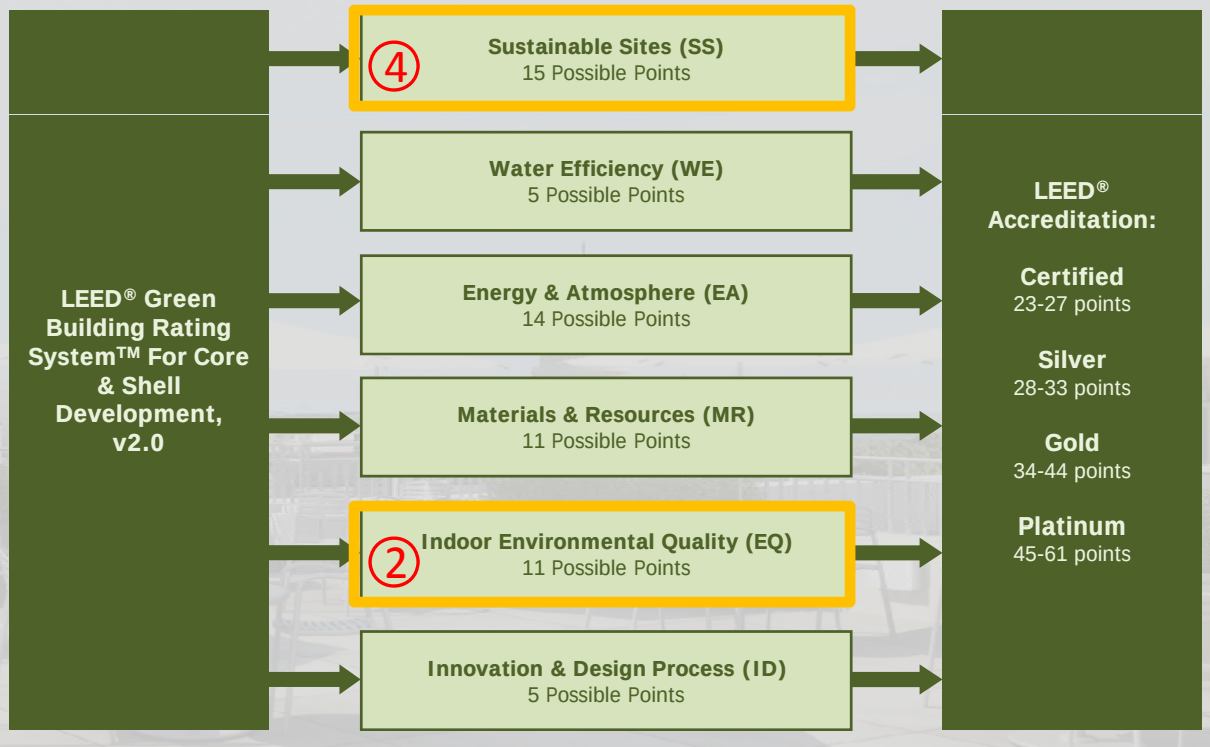
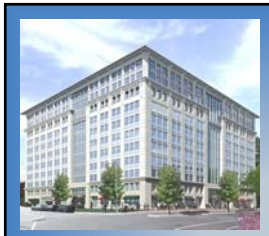
LEED for Core & Shell Development





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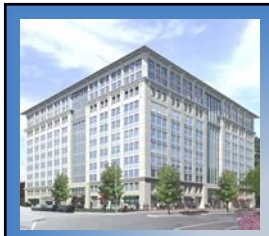
Commercial Office Building Assessment: An Owner's Perspective

Goals:

- Assess owners' views on LEED accreditation
- Investigate the methodology for determining whether or not to pursue accreditation
- Determine how LEED accreditation has benefited past projects
- Compare tenant agreements between LEED projects vs. non-accredited projects
- Assess future trends in LEED accreditation within the office building market

Resources and Tools:

- Online survey developed and distributed via SurveyMonkey.com
- Thirteen owner representative responses were collected



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Deciding Whether or Not to Pursue Accreditation?

PRIMARY IMPORTANCE	SECONDARY CRITERIA
Financial Analysis	Target Tenant Profile
Corporate Policy	Market Trends

Financial Analysis:

- Most common selection procedure. A cost-performance assessment is completed to determine if in the long run, LEED accreditation is profitable.

Corporate Policy:

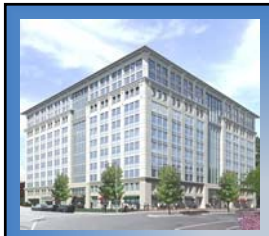
- All projects pursue a minimum accreditation level.

Target Tenant Profile:

- Evaluated based on known or anticipated tenant.

Market Trends:

- Based on local market and similar projects competing for the same tenant base.



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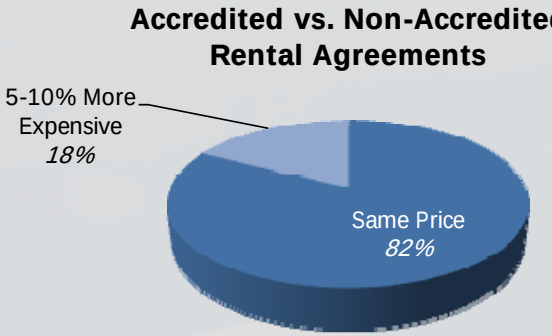
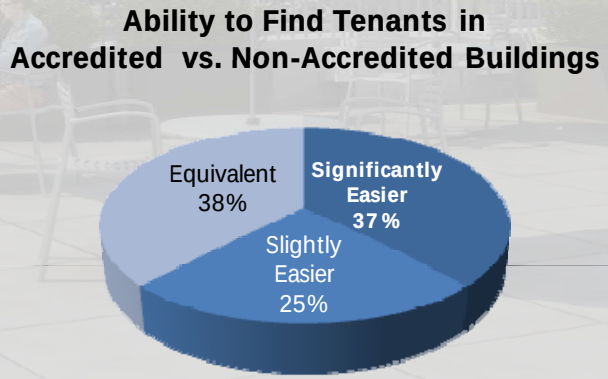
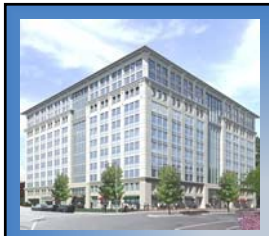
The Current LEED Environment



- Independent of utility agreement structure
  - If landlord pays, landlord saves long term
  - If tenant pays, LEED is seen as a marketing tool
- In the current market, tenants are unwilling to pay more, unless they demand high accreditation levels (Gold or Platinum)



- LEED is a marketing tool
- Differentiator between similar projects
- Allows a development company to gain a competitive advantage.



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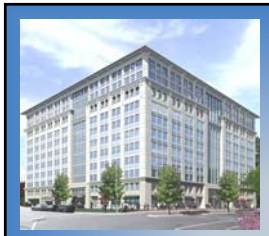
Tenant Evaluation

- The larger a company, the more willing they may be to pay more for LEED space.

- Larger companies and governmental agencies may have corporate policies regarding LEED occupancy.

> *"Some tenants have a corporate awareness; even a corporate directive about occupying LEED certified buildings, at a minimum. It's a corporate iconic statement about meeting energy and environmental obligations."*

- Smaller, bottom-line driven companies may be less inclined to pay more to occupy a LEED space even when presented with the added benefits.



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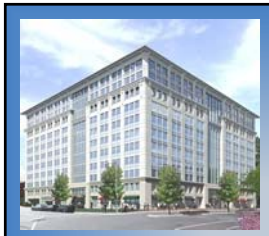
Conclusions

- LEED accreditation is only beginning to grow in popularity.
- LEED spaces are generally leased at equivalent prices to non-accredited spaces with similar features.
- Accreditation is seen as a strong marketing tool.
- It is a differentiator when a tenant considers a similar space at a similar cost that is or is not LEED accredited.
- Sustainable design is becoming more and more enticing given rising energy and fuel costs.



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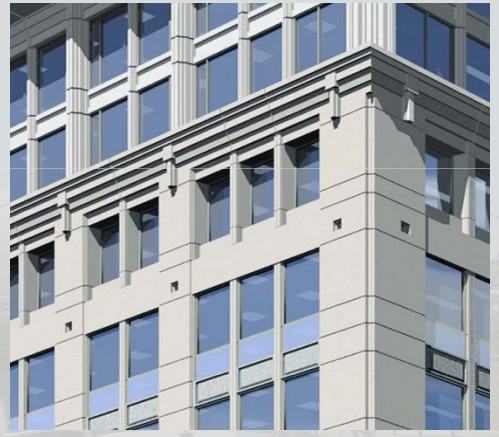
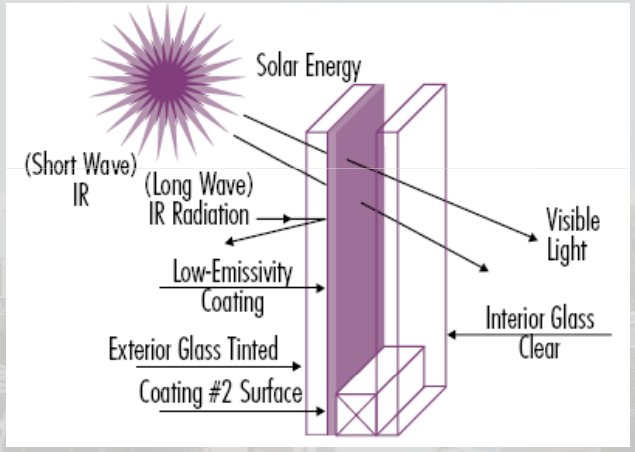
Glazing Alternative Analysis

Problem:

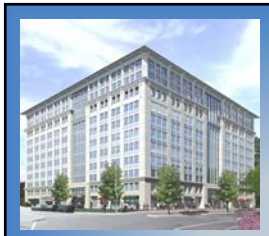
- Glazing system does not minimize heat transfer through the building envelope





Solution:

- Perform a value engineering assessment to select a more efficient glazing type that minimizes solar heat gain
- Optimize initial and life cycle operating costs



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Viracon Insulating Glass Unit Glazing Options

Glass Type	Transmittance			Reflectance			U-Value		SHGC	$/SF
	Visible	Solar	U-V	Vis-Out	Vis-In	Solar	Winter	Summer		
VE 1-85	76%	47%	26%	12%	13%	21%	0.31	0.29	0.54	$13.30
VRE 1-67	60%	32%	20%	29%	25%	35%	0.30	0.27	0.37	$13.30
VNE 1-63	62%	23%	4%	10%	11%	36%	0.29	0.25	0.28	$14.80

VE 1-85:

Existing glazing type

Clear vision glass

Low-emissivity

High visible transmittance

VRE 1-67:

Hybrid, low- e coating

Reduced solar heat gain

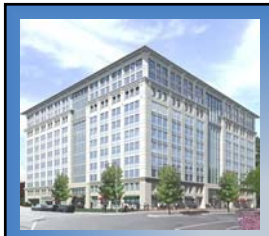
WSFS Bank Center: Wilmington, DE
Glass Type: VRE 1-67
(Source: Viracon)

VNE 1-63:

Solar performance of hybrid

Low transmittance of traditional low-e coatings

Ideal for sustainable projects



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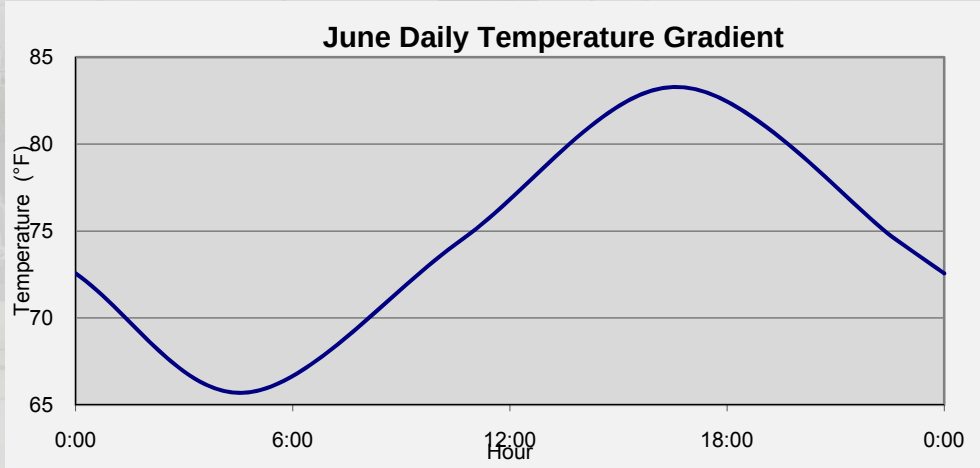
Fenestration Heat Gain Analysis:

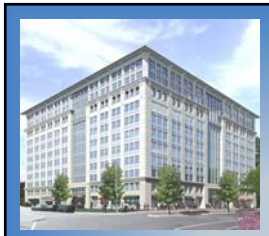
$$Q = Q_{con} + Q_{solar}$$

$$Q = UA(t_{out} - t_{in}) + SHGC(A_{pf})(E_t)$$

Step 1: Calculate Hourly Outside Temperature

- Collect sunrise, sunset data from United States Naval Observatory (USNO)
- Collect monthly temperatures data from the National Oceanic and Atmospheric Administration (NOAA)





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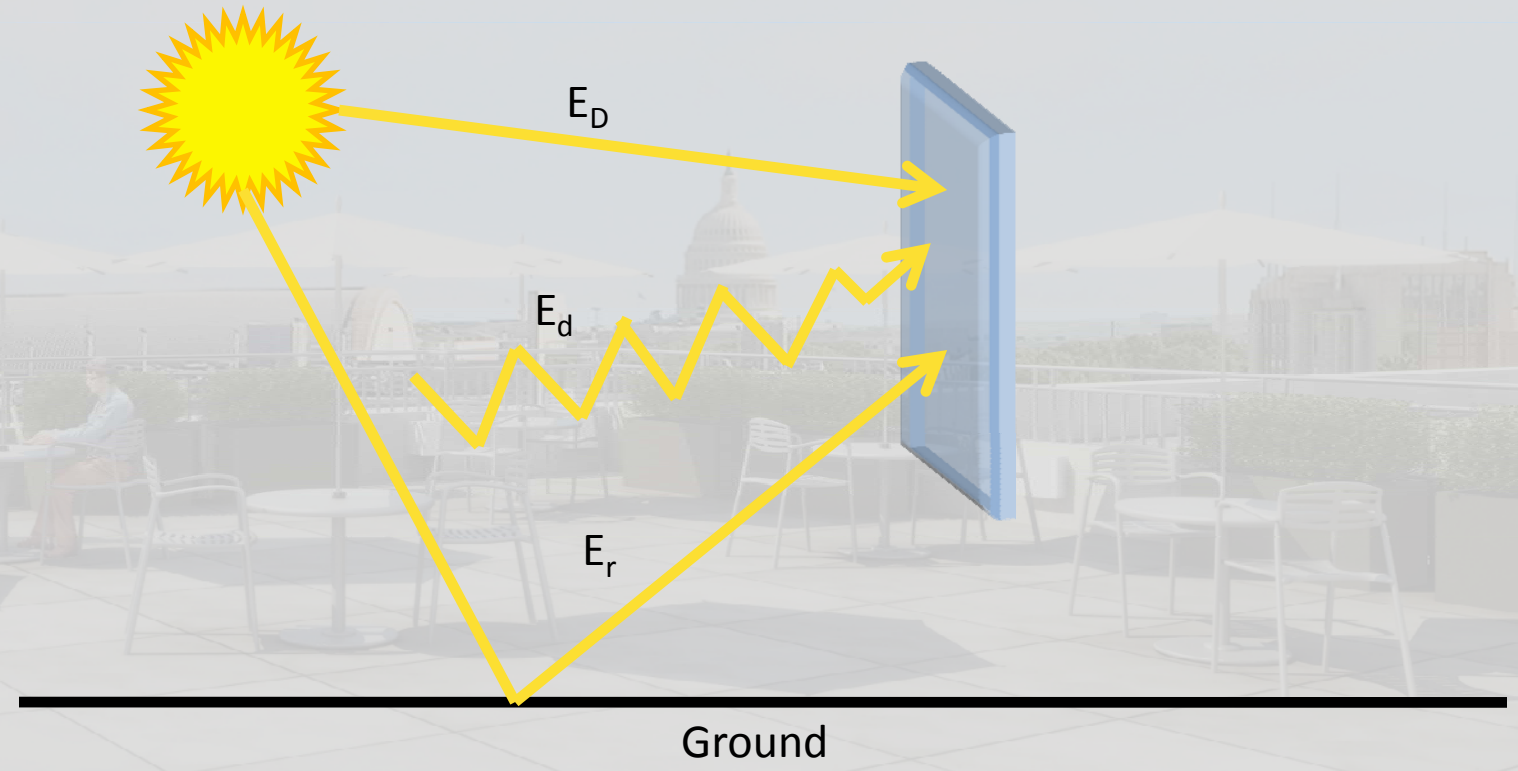
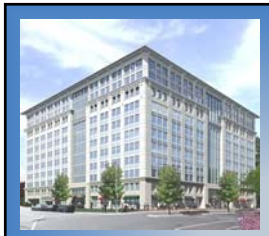
Step 2: Calculate Total Surface Irradiance (E_t)

Total Irradiance = Direct Irradiance + Diffuse Irradiance + Ground Reflected Irradiance

$$E_t = E_D + E_d + E_r$$





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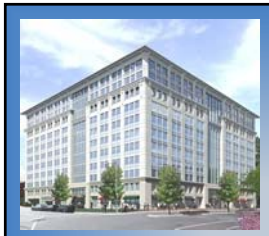
Step 2: Calculate Total Surface Irradiance (E_t)

Total Irradiance = Direct Irradiance + Diffuse Irradiance + Ground Reflected Irradiance

$$E_t = E_D + E_d + E_r$$

January Total Surface Irradiance

							North						South						East						West					
LST	AST	H	δ	ϕ	EDN	Bi Diffuse Ground Reflected Irr	γ	θ	ED	Y	Ed	Et	γ	θ	ED	Y	Ed	Et	γ	θ	ED	Y	Ed	Et	γ	θ	ED	Y	Ed	Et
Local Standard Time	Apparent Solar Time	Hour Angle	Solar Altitude	Solar Azimuth	Direct Normal Irradiance		Surface Solar Azimuth	Incident Angle	Surface Direct Irradiance	Sky Diffuse Ratio	Diffuse Irradiance	Total Surface Irradiance	Surface Solar Azimuth	Incident Angle	Surface Direct Irradiance	Sky Diffuse Ratio	Diffuse Irradiance	Total Surface Irradiance	Surface Solar Azimuth	Incident Angle	Surface Direct Irradiance	Sky Diffuse Ratio	Diffuse Irradiance	Total Surface Irradiance	Surface Solar Azimuth	Incident Angle	Surface Direct Irradiance	Sky Diffuse Ratio	Diffuse Irradiance	Total Surface Irradiance
0	-0.32	-154.63	-70.66	166.16	0.00	0.00	-12.62	71.34	0.00	0.72	0.00	0.00	166.16	105.76	0.00	0.45	0.00	0.00	256.16	94.54	0.00	0.52	0.00	0.00	76.16	55.46	0.00	0.59	0.00	0.00
1	0.68	-169.63	-69.17	152.16	0.00	0.00	-27.62	71.67	0.00	0.72	0.00	0.00	152.16	105.33	0.00	0.45	0.00	0.00	242.16	99.55	0.00	0.49	0.00	0.00	62.16	50.45	0.00	0.63	0.00	0.00
2	1.68	-154.63	-61.23	123.52	0.00	0.00	-56.15	74.47	0.00	0.69	0.00	0.00	123.52	105.53	0.00	0.45	0.00	0.00	213.52	113.56	0.00	0.45	0.00	0.00	33.52	66.44	0.00	0.77	0.00	0.00
3	2.68	-139.63	-50.68	106.94	0.00	0.00	-73.06	79.36	0.00	0.64	0.00	0.00	106.94	106.64	0.00	0.45	0.00	0.00	196.94	127.31	0.00	0.45	0.00	0.00	16.94	52.69	0.00	0.93	0.00	0.00
4	3.68	-124.63	-39.23	95.24	0.00	0.00	-84.76	85.94	0.00	0.56	0.00	0.00	95.24	94.06	0.00	0.52	0.00	0.00	185.24	140.47	0.00	0.45	0.00	0.00	5.24	39.53	0.00	1.07	0.00	0.00
5	4.68	-109.63	-27.57	85.72	0.00	0.00	-94.25	93.79	0.00	0.52	0.00	0.00	85.72	86.21	0.00	0.55	0.00	0.00	175.72	152.13	0.00	0.45	0.00	0.00	-4.28	27.87	0.00	1.15	0.00	0.00
6	5.68	-94.63	-16.04	76.95	0.00	0.00	-103.02	102.51	0.00	0.45	0.00	0.00	76.95	77.49	0.00	0.66	0.00	0.00	166.95	159.45	0.00	0.45	0.00	0.00	-13.02	20.55	0.00	1.22	0.00	0.00
7	6.68	-79.63	-4.91	68.16	0.00	0.00	-111.82	111.74	0.00	0.45	0.00	0.00	68.16	68.26	0.00	0.75	0.00	0.00	158.16	167.66	0.00	0.45	0.00	0.00	-21.82	12.34	0.00	1.22	0.00	0.00
8	7.68	-64.63	5.52	59.70	55.97	2.74	-121.30	121.14	0.00	0.45	2.98	6.73	59.70	59.66	44.46	0.56	7.61	54.81	149.70	149.26	0.00	0.45	2.98	6.73	-31.30	31.74	73.11	1.15	10.17	56.02
9	8.68	-49.63	14.90	47.99	214.65	12.37	-132.01	130.30	0.00	0.45	9.95	22.32	47.99	49.70	126.53	0.96	21.30	172.50	137.99	125.89	0.00	0.45	9.95	22.32	-42.01	44.11	154.13	1.03	22.67	159.16
10	9.68	-34.63	22.65	35.57	257.72	20.15	-144.43	138.63	0.00	0.45	11.95	32.09	35.57	41.37	192.41	1.05	27.99	241.55	125.57	122.46	0.00	0.45	11.95	32.09	-54.43	57.54	136.32	0.87	23.22	151.69
11	10.68	-19.63	28.25	21.22	275.77	25.43	-156.75	145.20	0.00	0.45	12.76	38.21	21.22	34.80	226.46	1.12	31.51	283.70	111.22	108.59	0.00	0.45	12.76	38.21	-68.78	71.41	57.91	0.72	20.46	123.82
12	11.68	-4.63	30.94	5.29	252.37	27.85	-174.71	145.66	0.00	0.45	13.09	40.97	5.29	31.34	241.16	1.15	33.49	302.54	96.29	94.54	0.00	0.52	15.05	42.93	-84.71	85.46	22.34	0.59	17.06	67.26
13	12.68	10.17	30.34	11.05	251.01	27.34	-165.92	147.86	0.00	0.45	13.02	40.37	11.05	32.12	237.99	1.14	33.13	295.46	101.05	99.55	0.00	0.49	14.07	41.41	-78.95	80.45	46.62	0.63	18.27	92.34
14	13.68	25.17	26.57	26.54	271.03	23.86	-153.46	143.15	0.00	0.45	12.56	36.42	26.54	36.65	216.66	1.10	30.71	271.42	116.54	113.56	0.00	0.45	12.56	36.42	-63.46	66.44	105.32	0.77	21.62	153.50
15	14.68	40.17	20.13	40.21	246.61	17.64	-139.79	135.51	0.00	0.45	11.43	29.07	40.21	44.19	176.82	1.02	26.02	220.45	130.21	127.31	0.00	0.45	11.43	29.07	-49.79	52.69	149.45	0.93	23.62	190.75
16	15.68	55.17	11.71	51.95	155.48	9.05	-125.02	127.10	0.00	0.45	8.60	17.65	51.95	52.90	111.67	0.93	17.73	138.67	141.95	140.47	0.00	0.45	8.60	17.65	-35.02	39.53	143.07	1.07	20.50	172.65
17	16.68	70.17	1.91	62.19	5.44	0.12	-117.81	117.80	0.00	0.45	0.25	0.37	62.19	62.20	2.54	0.82	0.46	3.12	152.19	152.13	0.00	0.45	0.25	0.37	-27.81	27.87	4.81	1.15	0.68	5.59
18	17.68	85.17	-8.51	71.36	0.00	0.00	-108.64	108.41	0.00	0.45	0.00	0.00	71.36	71.59	0.00	0.72	0.00	0.00	161.36	159.45	0.00	0.45	0.00	0.00	-18.64	20.55	0.00	1.22	0.00	0.00
19	18.68	100.17	-20.11	80.06	0.00	0.00	-99.94	99.33	0.00	0.49	0.00	0.00	80.06	80.67	0.00	0.83	0.00	0.00	170.06	167.66	0.00	0.45	0.00	0.00	-9.94	12.34	0.00	1.22	0.00	0.00
20	19.68	115.17	-31.72	88.97	0.00	0.00	-91.03	90.55	0.00	0.54	0.00	0.00	88.97	89.12	0.00	0.96	0.00	0.00	178.97	176.26	0.00	0.45	0.00	0.00	-1.03	31.74	0.00	1.15	0.00	0.00
21	20.68	130.17	-43.36	99.05	0.00	0.00	-80.95	80.42	0.00	0.60	0.00	0.00	99.05	98.57	0.00	0.50	0.00	0.00	189.05	185.89	0.00	0.45	0.00	0.00	9.05	44.11	0.00	1.03	0.00	0.00
22	21.68	145.17	-54.80	112.11	0.00	0.00	-67.89	67.40	0.00	0.66	0.00	0.00	112.11	102.60	0.00	0.45	0.00	0.00	202.11	122.46	0.00	0.45	0.00	0.00	22.11	57.54	0.00	0.87	0.00	0.00
23	22.68	160.17	-64.52	122.17	0.00	0.00	-47.83	73.22	0.00	0.70	0.00	0.00	122.17	106.76	0.00	0.45	0.00	0.00	222.17	106.59	0.00	0.45	0.00	0.00	42.17	71.41	0.00	0.72	0.00	0.00



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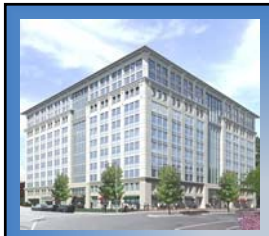
Step 2: Calculate Total Surface Irradiance (E_t)

Total Irradiance = Direct Irradiance + Diffuse Irradiance + Ground Reflected Irradiance

$$E_t = E_D + E_d + E_r$$

							North					
LST	AST	H	β	ϕ	EDN	Er	γ	θ	ED	Y	Ed	Et
Local Standard Time	Apparent Solar Time	Hour Angle	Solar Altitude	Solar Azimuth	Direct Normal Irradiance	Diffuse Ground-Reflected Ir	Surface-Solar Azimuth	Incident Angle	Surface Direct Irradiance	Sky Diffuse Ratio	Diffuse Irradiance	Total Surface Irradiance
7	6.68	-79.83	-4.91	68.18	0.00	0.00	-111.82	111.74	0.00	0.45	0.00	0.00
8	7.68	-64.83	5.53	58.70	85.97	2.74	-121.30	121.14	0.00	0.45	3.98	6.73
9	8.68	-49.83	14.90	47.99	214.65	12.37	-132.01	130.30	0.00	0.45	9.95	22.32
10	9.68	-34.83	22.68	35.57	257.72	20.15	-144.43	138.63	0.00	0.45	11.95	32.09
11	10.68	-19.83	28.25	21.22	275.77	25.43	-158.78	145.20	0.00	0.45	12.78	38.21
12	11.68	-4.83	30.94	5.29	282.37	27.88	-174.71	148.66	0.00	0.45	13.09	40.97



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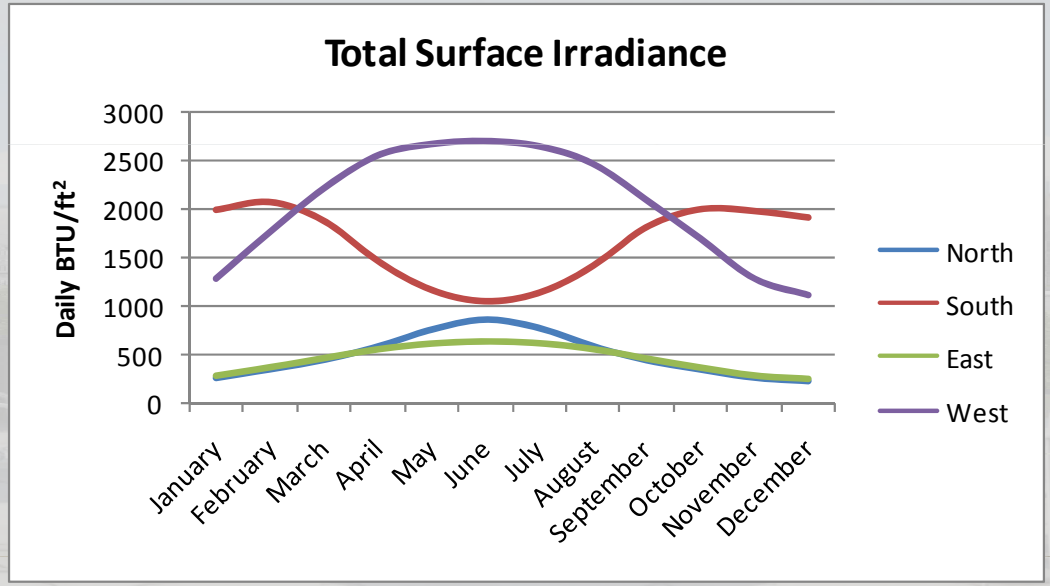
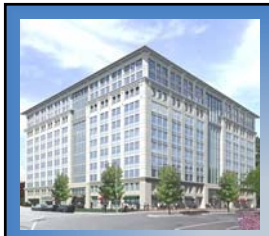
Step 2: Calculate Total Surface Irradiance (E_t)

Total Irradiance = Direct Irradiance + Diffuse Irradiance + Ground Reflected Irradiance

$$E_t = E_D + E_d + E_r$$





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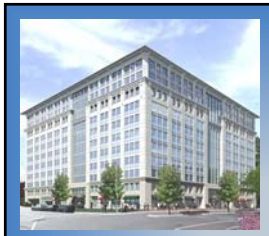
Step 3: Perform Solar Heat Gain Analysis

$$Q = UA(t_{out} - t_{in}) + SHGC(A_{pf})(E_t)$$

January Fenestration Analysis

	CONDUCTION = $Q_{cond} = UA(\Delta t)$						SOLAR RADIATION = $Q_{sol} = SHGC(A)(E_t)$							TOTAL ENERGY TRANSFER			SAVINGS (Cooling Only)	
time	T_o	T_i	ΔT	VE 1-85	VRE 1-67	VNE 1-63	$E_{t,N}$	$E_{t,S}$	$E_{t,E}$	$E_{t,W}$	VE 1-85	VRE 1-67	VNE 1-63	VE 1-85	VRE 1-67	VNE 1-63	VRE 1-67	VNE 1-63
0:00	41.0	60	-19.0	-143009.2	-138396	-133783	0.00	0.00	0.00	0.00	0	0	0	-143009	-138396	-133783	0	0
1:00	40.0	60	-20.0	-150536	-145680	-140824	0.00	0.00	0.00	0.00	0	0	0	-150536	-145680	-140824	0	0
2:00	38.7	60	-21.3	-160320.84	-155149.2	-149978	0.00	0.00	0.00	0.00	0	0	0	-160321	-155149	-149978	0	0
3:00	37.5	60	-22.5	-169353	-163890	-158427	0.00	0.00	0.00	0.00	0	0	0	-169353	-163890	-158427	0	0
4:00	36.3	60	-23.7	-178385.16	-172630.8	-166876	0.00	0.00	0.00	0.00	0	0	0	-178385	-172631	-166876	0	0
5:00	35.5	60	-24.5	-184406.6	-178458	-172509	0.00	0.00	0.00	0.00	0	0	0	-184407	-178458	-172509	0	0
6:00	35.0	70	-35.0	-263438	-254940	-246442	0.00	0.00	0.00	0.00	0	0	0	-263438	-254940	-246442	0	0
7:00	35.3	70	-34.7	-261179.96	-252754.8	-244330	0.00	0.00	0.00	0.00	0	0	0	-261180	-252755	-244330	0	0
8:00	36.8	70	-33.2	-249889.76	-241828.8	-233768	6.73	54.81	6.73	86.02	510730	368861	264823	260840	127032	31055	133808	229785
9:00	39.3	70	-30.7	-231072.76	-223618.8	-216165	22.32	172.50	22.32	189.16	1342815	969811	696275	1111743	746192	480110	365550	631633
10:00	42.3	70	-27.7	-208492.36	-201766.8	-195041	32.09	241.55	32.09	181.69	1608417	1161634	833994	1399925	959868	638953	440057	760972
11:00	45.5	70	-24.5	-184406.6	-178458	-172509	38.21	283.70	38.21	133.82	1627135	1175153	843700	1442728	996695	671190	446033	771538
12:00	50.0	70	-20.0	-150536	-145680	-140824	40.97	302.54	42.93	67.28	1491941	1077513	773599	1341405	931833	632775	409572	708630
13:00	51.2	70	-18.8	-141503.84	-136939.2	-132375	40.37	298.46	41.41	92.24	1554675	1122821	806128	1413171	985882	673753	427290	739418
14:00	51.0	70	-19.0	-143009.2	-138396	-133783	36.42	271.43	36.42	153.80	1641798	1185743	851303	1498789	1047347	717520	451442	781269
15:00	50.3	70	-19.7	-148277.96	-143494.8	-138712	29.07	220.48	29.07	190.75	1549764	1119274	803581	1401486	975779	664870	425707	736616
16:00	49.3	70	-20.7	-155804.76	-150778.8	-145753	17.68	138.67	17.68	172.65	1146461	827999	594461	990656	677221	448708	313435	541948
17:00	48.5	70	-21.5	-161826.2	-156606	-151386	0.37	3.12	0.37	5.59	31310	22613	16235	-130516	-133993	-135151	0	0
18:00	47.3	70	-22.7	-170858.36	-165346.8	-159835	0.00	0.00	0.00	0.00	0	0	0	-170858	-165347	-159835	0	0
19:00	46.2	70	-23.8	-179137.84	-173359.2	-167581	0.00	0.00	0.00	0.00	0	0	0	-179138	-173359	-167581	0	0
20:00	45.0	70	-25.0	-188170	-182100	-176030	0.00	0.00	0.00	0.00	0	0	0	-188170	-182100	-176030	0	0
21:00	44.0	60	-16.0	-120428.8	-116544	-112659	0.00	0.00	0.00	0.00	0	0	0	-120429	-116544	-112659	0	0
22:00	42.9	60	-17.1	-128708.28	-124556.4	-120405	0.00	0.00	0.00	0.00	0	0	0	-128708	-124556	-120405	0	0
23:00	42.0	60	-18.0	-135482.4	-131112	-126742	0.00	0.00	0.00	0.00	0	0	0	-135482	-131112	-126742	0	0
														8296813	4958938	2547364	3412895	5901809



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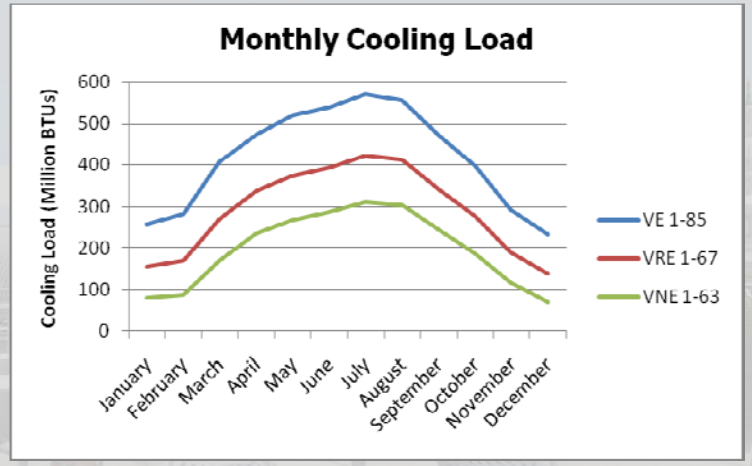
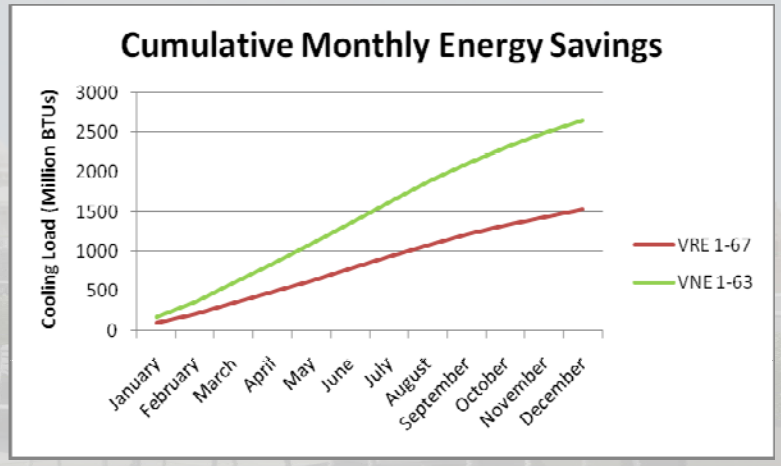
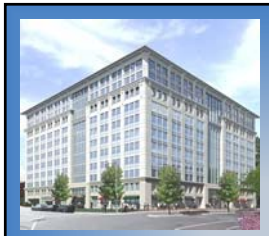
Step 3: Perform Solar Heat Gain Analysis

$$Q = UA(t_{out} - t_{in}) + SHGC(A_{pf})(E_t)$$







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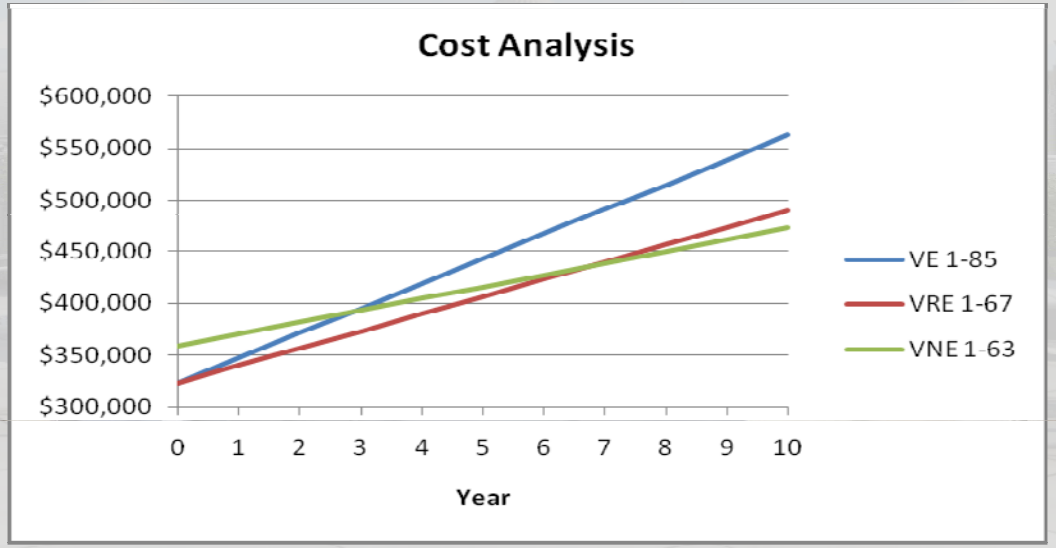
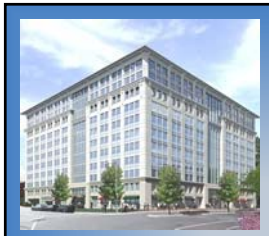
Step 4: Calculate Cooling Load Cost Savings

$$\$/yr = \frac{(BTU/yr)(\$/kWh)}{(SEER)(1{,}000\ W/kW)}$$

Glass Type	$/SF	Initial Cost	Annual Cooling Cost	Annual Cooling Savings
VE 1-85	$13.30	$322,924	$24,009.21	----
VRE 1-67	$13.30	$322,924	$16,663.37	$7,346
VNE 1-63	$14.80	$359,344	$11,296.87	$12,712





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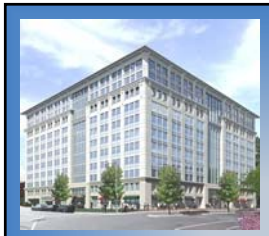
LEED Impact:

# of Credits	LEED Credit	Likely	Possibly	Contributor
2-8	Energy and Atmosphere 1.0 *Optimizing Energy Performance*			X
1-2	Materials and Resources 4.1, 4.2 *Recycled Content*			X
1	Indoor Environmental Quality 8.1 *Daylight and Views*	X		
1	Indoor Environmental Quality 8.2 *Daylight and Views*	X		
1-4	Innovation & Design Process 1.1-1.4 *Innovation in Design*		X	



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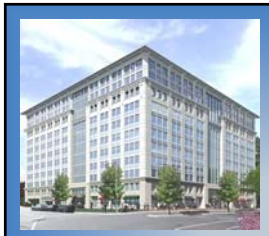
Green Roof Addition Analysis

Green Roof Benefits:

- Reduce energy demands
- Protect the waterproofing membrane and extend its lifespan
- Contribute LEED points
- Reduce storm water runoff
- Decrease the urban heat island effect
- Increase oxygen filtration and production
- Improve sound insulation
- Add recreational space
- Increase property value



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What Type of Green Roof?

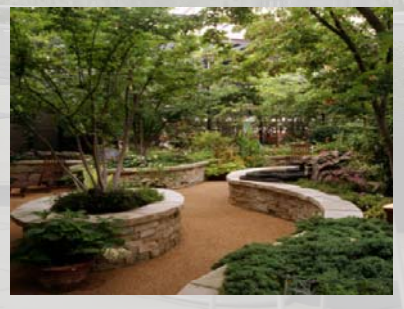
CHARACTERISTIC	EXTENSIVE	SEMI-EXTENSIVE	INTENSIVE
DEPTH OF GROWING MEDIUM	6" or less	25% above or below 6"	More than 6"
ACCESSIBILITY	Often inaccessible	May be partially accessible	Usually accessible
FULLY SATURATED WEIGHT *(approx. 6 lb/sf/in. depth)*	Low 12-35 lb/sf	Varies 25-50 lb/sf	High 50-200 lb/sf
PLANT DIVERSITY	Low	Greater	Greatest
INSTALLED COST	$10-20/sf	Varies	$20/sf or more
MAINTENANCE	Minimal	Varies	Highest

(Source: *Green Roofs for Healthy Cities*)

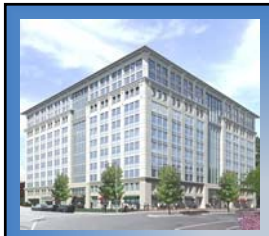
Extensive Roof

Semi-Intensive Roof

(Source: *Sika Sarnifil*)



Intensive Roof



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Structural Design

One-Way Structural Slab Design
30'-0" x 30'-0" typical bay with 24" x 24" columns
Design based on Concrete Reinforcing Steel Institute Design Handbook, 2002

Slab Design:

100 PSF Live Load

60 PSF Dead Load

Factored Load = 254 PSF

Min. Thickness = $\ell/28$ = 15'/28 = 6.4"

SLAB DESIGN THICKNESS: 6.5"

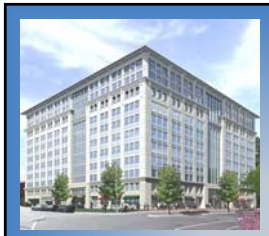
Top Bars, #5 @ 11"
Bottom Bars, #4 @ 10"
Temperature Bars, #4 @ 17"

Deflection Check: OK
Crack Control/Spacing: OK

SOLID ONE-WAY SLABS—INTERIOR SPAN — Top Steel for $-M_u$
f'_c = 3,000 psi — Grade 60 Bars — ρ = 0.0050

Thickness (in.)	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
Top Bars Spacing (in.)	#4 12	#4 11	#4 10	#4 9	#5 12	#5 11	#5 10	#5 10	#5 9	#6 12	#6 11	#6 10	#6 10
Bottom Bars Spacing (in.)	#3 10	#3 9	#3 7	#4 12	#4 11	#4 10	#4 10	#4 9	#4 8	#5 12	#5 11	#5 10	#5 10
T-S Bars Spacing (in.)	#3 15	#3 13	#3 12	#3 11	#4 18	#4 17	#4 15	#4 14	#4 13	#4 13	#4 12	#5 18	#5 17
Areas of Steel ($in.^2$/ft) Top Interior	.200	.218	.240	.267	.310	.338	.372	.372	.413	.440	.480	.528	.528
Bottom	.132	.147	.189	.200	.218	.240	.240	.267	.300	.310	.338	.372	.372
Slab Wt. (psf)	50	56	63	69	75	81	88	94	100	106	113	119	125

CLEAR SPAN	FACTORED USABLE SUPERIMPOSED LOAD (psf)												
6'-0"	703	923											
6'-6"	589	775											
7'-0"	498	657	907										
7'-6"	425	562	778	988									
8'-0"	365	485	673	856									
8'-6"	315	420	586	747	935								
9'-0"	273	367	513	656	822								
9'-6"	238	321	452	579	727	894	980						
10'-0"	208	282	399	513	646	795	872						
10'-6"	181	243	317	410	539	661	779	882					
11'-0"	159	214	281	365	482	592	699	792	964				
11'-6"	139	189	249	326	432	532	629	713	870	994			
12'-0"	122	167	222	291	388	479	568	644	787	901			
12'-6"	107	148	197	261	349	433	514	583	715	819	967		
13'-0"	94	131	176	234	315	392	465	529	650	746	882		
13'-6"	82	116	157	210	285	355	423	481	593	681	806	959	
14'-0"	71	102	139	188	257	322	384	438	541	623	739	880	939
14'-6"	61	90	124	169	233	293	350	400	495	570	678	809	863



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Beam Design:

100 PSF Live Load

141 PSF Dead Load

Factored Load = 368 PSF

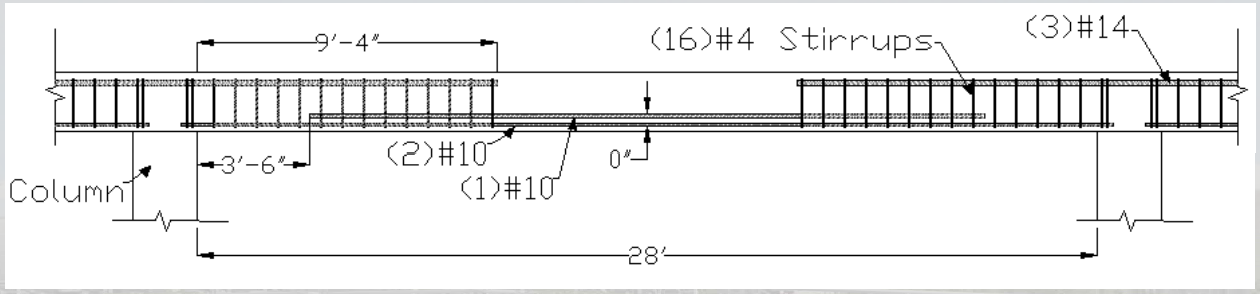
Factored Line Load = 5.927 KLF

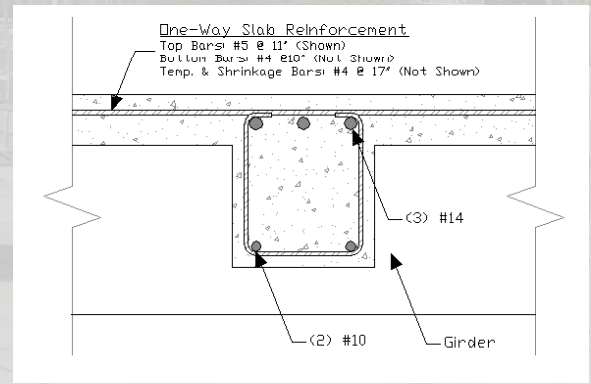
Beam Size: 18" x 22"

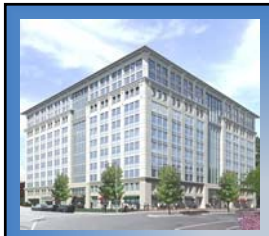
Bottom Bars, (2) #10 [l_n + 12"]
(1) #10 [0.875 l_n]

Top Bars, (3) #14

Open Stirrups, (16)#4: 1@2", 15@9"







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Girder Design:

Estimate Factored Girder Load, $[20' \times (28'\text{-}6\tfrac{3}{8}")](\frac{130 PSF}{144 in^2/ft^2})(1.4) = 627 PLF$

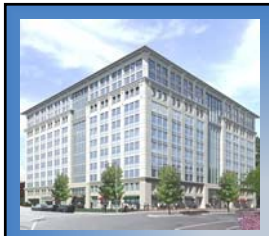
Moment from Mid-Span Concentrated Load (Beam) $M = \frac{(179 k \times 28')}{8} = 626.5 ft\text{-}kips$

Equivalent Uniform Load, $w = \frac{11M}{L_n^2} = \frac{11(626.5\ kips)}{(28')^2} = 8.74 kips/ft$

Total Factored Load (for $-M_u$), $w_u = 8.74 \frac{kips}{ft} + 0.63 \frac{kips}{ft} = 9.37 \frac{kips}{ft}$

Factored Positive Moment, $M_u = 452 kips + \frac{(0.63 \frac{kips}{ft})(28')^2}{16} = 634 kips$

Total Factored Load (for $+M_u$), $w_u = \frac{1.1(626.5\ kips)}{(28')^2} + 0.63 \frac{kips}{ft} = 1.33 \frac{kips}{ft}$



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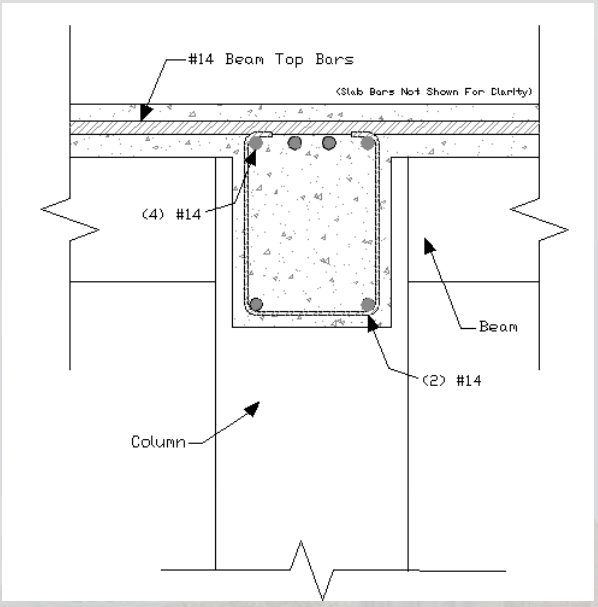
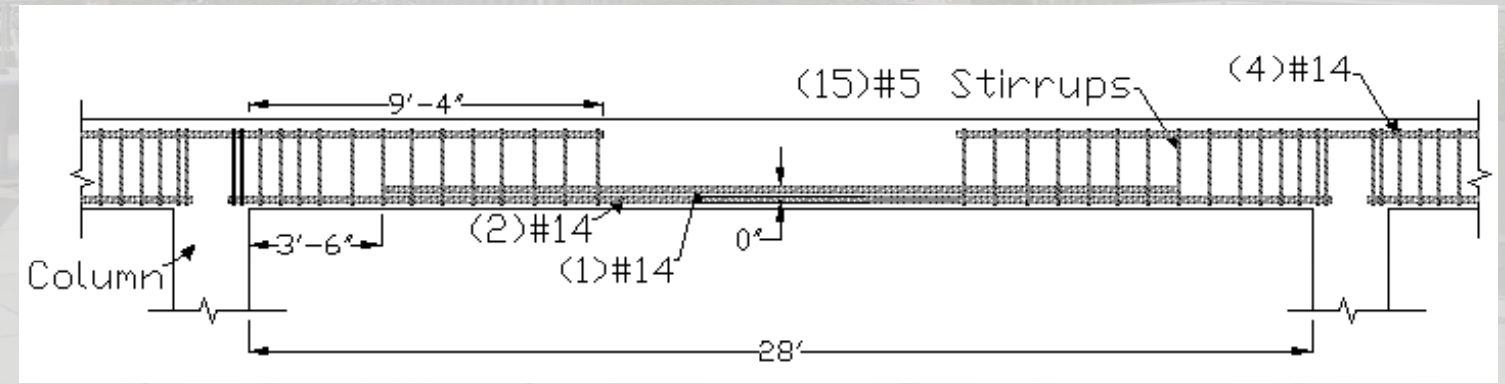
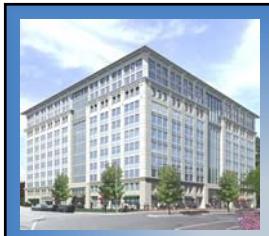
Girder Design:

Girder Size: 20" x 28"
Bottom Bars, (2) #14 [l_n + 12"]
(1) #14 [0.875 l_n]
Top Bars, (4) #14
Open Stirrups, (15)#5: 1@2", 5@8", 9@11"



Torsion Check: OK
Shear Check: OK
Bottom Bar Moment Check: OK





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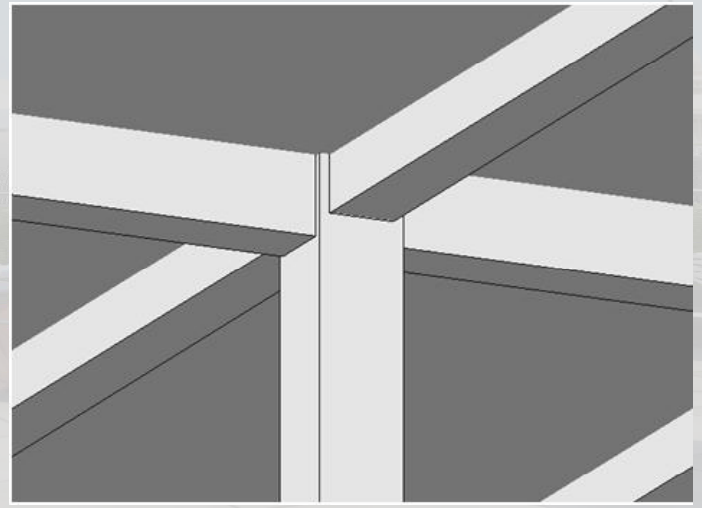
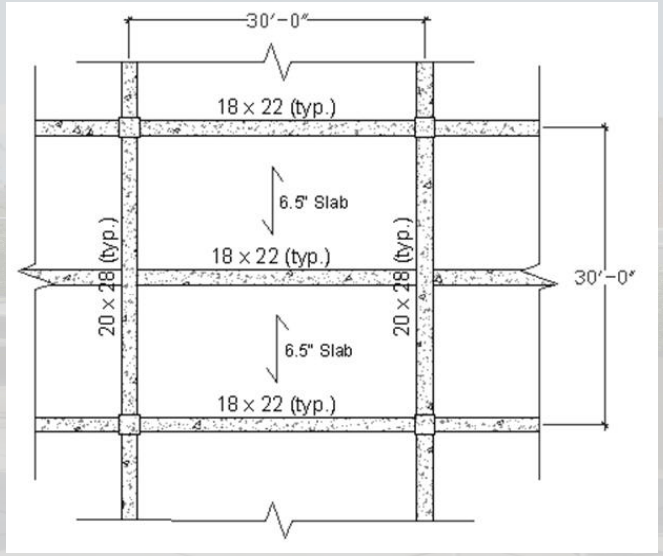
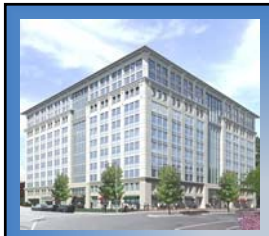
Roofing One-Way Slab Structural Redesign:

6.5” Slab
18” x 22” Beams
20” x 28” Girders







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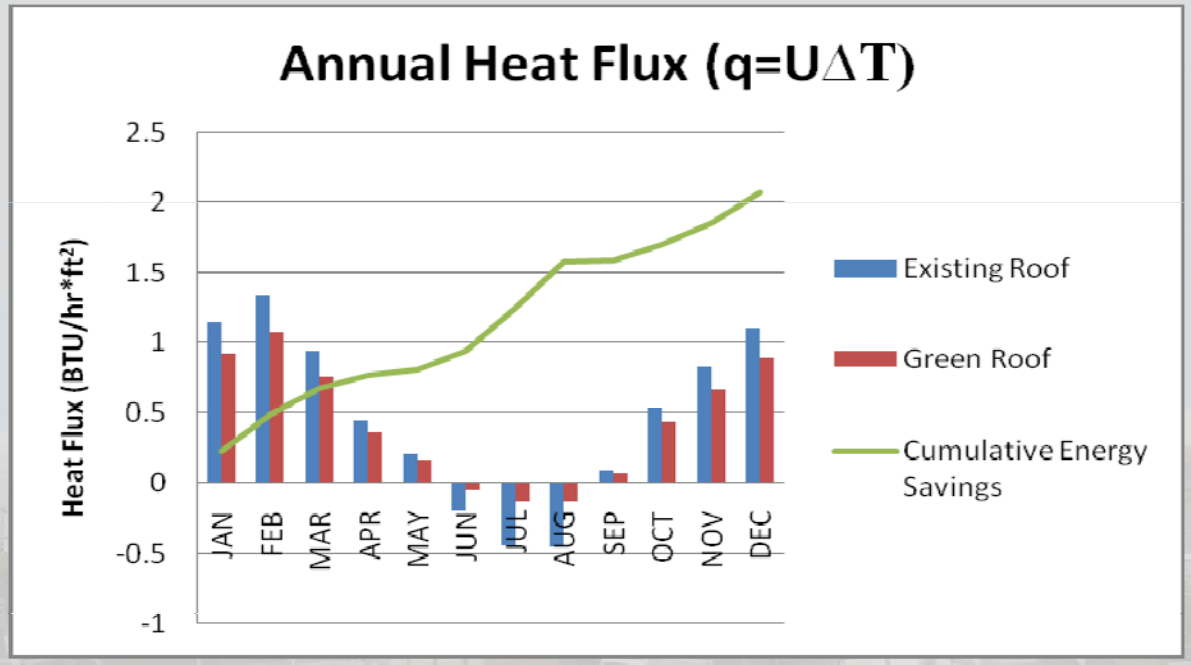
Energy Savings:

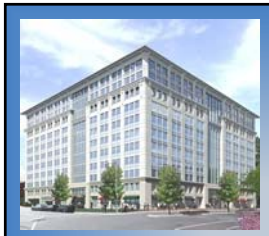


Q = Area * Cum. Annual Savings * Hours Per Day * Days Per Year

Q = (24,000 ft^2) * (2.073 BTU / Hr. * ft^2) * 24 Hrs/Day * 365.25 Days/Year

Q = 436,126,032 BTUs/Year

Annual Energy Savings: $2,073



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Cost Implications:

Existing Roof: 32,000 SF EPDM roofing membrane

Proposed Roof: 8,000 SF EPDM roofing membrane and 24,000 SF Green Roof

	Component	Cost / SF
Green Roof	Green Roof System (curbing, drainage layer, filter cloth, growing medium, pavers, etc.)	$11.00
	Plants	$3.50
	Installation / Labor	$8.00
	Total	**$22.50**

Existing EPDM Roof System

32,000 SF @ $9.80/SF = $313,600

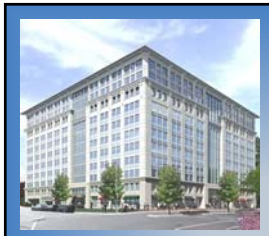
Total Cost = $313,600
Average Cost = $9.80/SF

Green Roof Redesign

8,000 SF @ $9.80/SF = $78,400
24,000 SF @ $22.50/SF = $540,000

Total Cost = $618,400
Average Cost = $19.32/SF

Additional Cost: $304,800



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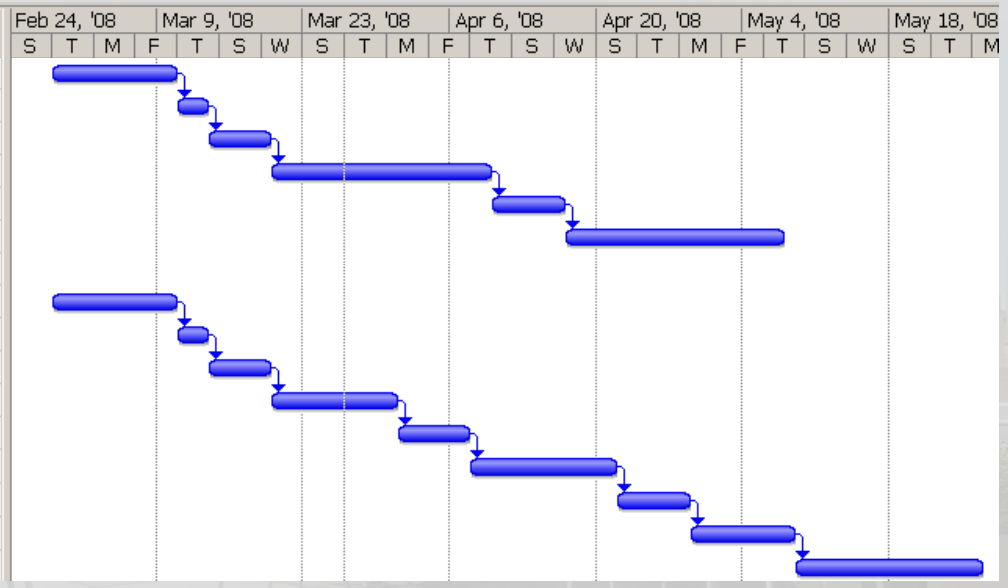
Schedule Implications:

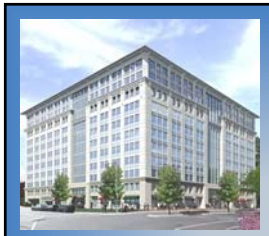
Existing Roof: 50 day schedule

Proposed Roof: 63 day schedule

	Task Name	Duration
Existing	Penthouse Roof Tar and Membrane	8 days
	Penthouse Roof Water Test	3 days
	Penthouse Roof Insulation and Ballast	4 days
	Main Roof Tar and Membrane	15 days
	Main Roof Water Test	5 days
	Main Roof Insulate and Ballast	15 days
Proposed	Penthouse Roof Tar and Membrane	8 days
	Penthouse Roof Water Test	3 days
	Penthouse Roof Insulation and Ballast	4 days
	Main Roof Waterproofing Membrane	8 days
	Main Roof Water Test	5 days
	Main Roof Protection Layer and Insulation	10 days
	Main Roof Drainage Composite	5 days
	Main Roof Pedestals and Pavers	8 days
	Main Roof Growth Medium and Vegetaion	12 days



Roofing Schedule Impact: ≈ 2.5 week increase



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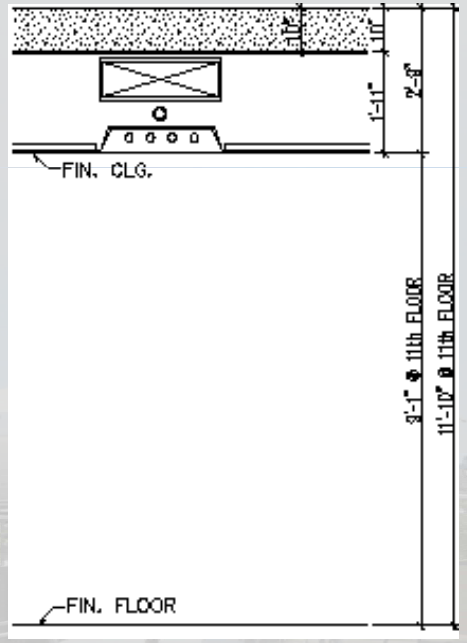
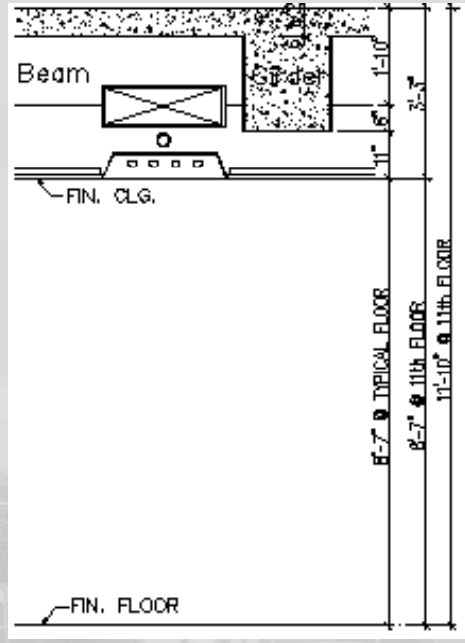
Plenum Space Implications:

Roof height can not be raised as a result of Washington, DC height restrictions.

Existing Condition

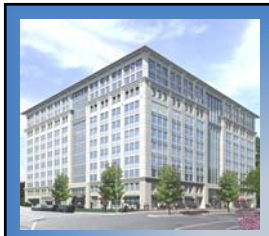


Proposed Condition



Ways of Remedying the Plenum Space Issue:

1. Resize ducts to fit below proposed girders.
2. Lower the finished ceiling height.
3. Provide cutouts and reinforcing in the girders to accommodate ducts.



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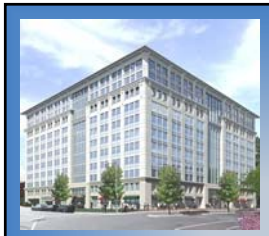
LEED Impact:

# of Credits	LEED Credit	Likely	Possibly	Contributor
1	Sustainable Sites 6.1 *Stormwater Design: Quantity Control*	X		
1	Sustainable Sites 7.2 *Heat Island Effect: Roof*	X		
1	Water Efficiency 1.1 *Water-Efficient Landscaping*		X	
2-8	Energy and Atmosphere 1.0 *Optimizing Energy Performance*			X
1-2	Materials and Resources 4.1, 4.2 *Recycled Content*			X
1-2	Materials and Resources 5.1, 5.2 *Local and Regional Materials*			X



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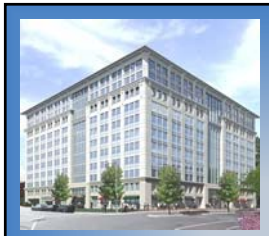
Equivalent Uniform Annual Cost Analysis

Objective:

• As was discovered in the owner assessment , financial profitability is a primary concern for many companies pursuing LEED accreditation. How do the proposed changes perform financially?



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Equivalent Uniform Annual Cost Analysis

	ROOFING		GLAZING	
	Existing	Proposed	Existing	Proposed
Type	Ballasted EPDM	Green Roof	VE 1-85	VNE 1-63
Life	20 years	40 years	25 years	25 years
Initial Cost	$313,600	$618,400	$322,924	$359,344
Annual Maintenance	$8,000	$14,000	----	----
Annual Energy Savings	----	-$2,903	----	-$12,712

(Assumes an annual interest rate of 7%.)

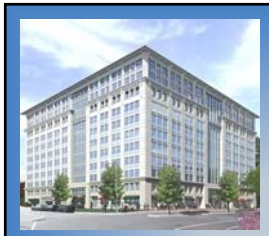
$EUAC_{Existing}$ = $313,600(A/P, 7%, 20) + $8,000 + $322,924(A/P, 7%, 25)
= $65,310

$EUAC_{Proposed}$ = $618,400(A/P, 7%, 40) + $14,000 -$2,903 +$359,344(A/P, 7%, 25) - $12,712
= $72,000

$6,690 Annually = Less than $0.01 per month per square foot

Recommendation:

Pursue sustainable design objectives by incorporating a green roof and an alternative glazing type.



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Potential LEED Status

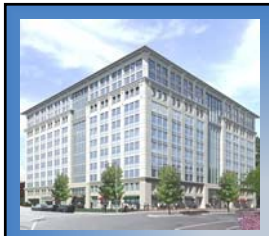
LEED for Core and Shell v2.0
Registered Project Checklist

Project Address:

Likely	Poss.	Contr.			
6			**Sustainable Sites**		**15** Points
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
1			Credit 1	**Site Selection**	1
1			Credit 2	**Development Density & Community Connectivity**	1
			Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation:** Public Transportation Access	1
			Credit 4.2	**Alternative Transportation:** Bicycle Storage & Changing Rooms	1
			Credit 4.3	**Alternative Transportation:** Low-Emitting and Fuel-Efficient Vehicles	1
			Credit 4.4	**Alternative Transportation:** Parking Capacity	1
			Credit 5.1	**Site Development:** Protect of Restore Habitat	1
			Credit 5.2	**Site Development:** Maximize Open Space	1
1			Credit 6.1	**Stormwater Design:** Quantity Control	1
			Credit 6.2	**Stormwater Design:** Quality Control	1
1			Credit 7.1	**Heat Island Effect,** Non-Roof	1
1			Credit 7.2	**Heat Island Effect,** Roof	1
			Credit 8	**Light Pollution Reduction**	1
			Credit 9	**Tenant Design & Construction Guidelines**	1
Likely	Poss.	Contr.			
	1		**Water Efficiency**		**5** Points
	1		Credit 1.1	**Water Efficient Landscaping:** Reduce by 50%	1
			Credit 1.2	**Water Efficient Landscaping:** No Potable Use or No Irrigation	1
			Credit 2	**Innovative Wastewater Technologies**	1
			Credit 3.1	**Water Use Reduction:** 20% Reduction	1
			Credit 3.2	**Water Use Reduction:** 30% Reduction	1
Likely	Poss.	Contr.			
2	1		**Energy & Atmosphere**		**14** Points
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
			*Note for EAc1: All LEED for Core and Shell projects registered after June 26th, 2007 are required to achieve at least two (2) points under EAc1.		
2	1		Credit 1	**Optimize Energy Performance**	1 to 8
				10.5% New Buildings or 3.5% Existing Building Renovations	1
			2	14% New Buildings or 7% Existing Building Renovations	2
				17.5% New Buildings or 10.5% Existing Building Renovations	3
				21% New Buildings or 14% Existing Building Renovations	4
				24.5% New Buildings or 17.5% Existing Building Renovations	5
				28% New Buildings or 21% Existing Building Renovations	6
				31.5% New Buildings or 24.5% Existing Building Renovations	7
				35% New Buildings or 28% Existing Building Renovations	8
			Credit 2	**On-Site Renewable Energy**	1
			Credit 3	**Enhanced Commissioning**	1
			Credit 4	**Enhanced Refrigerant Management**	1
			Credit 5.1	**Measurement & Verification** - Base Building	1
			Credit 5.2	**Measurement & Verification** - Tenant Sub-metering	1
			Credit 6	**Green Power**	1

Likely	Poss.	Contr.			
		4	**Materials & Resources**		**11** Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
			Credit 1.1	**Building Reuse:** Maintain 25% of Existing Walls, Floors & Roof	1
			Credit 1.2	**Building Reuse:** Maintain 50% of Existing Walls, Floors & Roof	1
			Credit 1.3	**Building Reuse:** Maintain 75% of Interior Non-Structural Elements	1
			Credit 2.1	**Construction Waste Management:** Divert 50% from Disposal	1
			Credit 2.2	**Construction Waste Management:** Divert 75% from Disposal	1
			Credit 3	**Materials Reuse:** 1%	1
		1	Credit 4.1	**Recycled Content:** 10% (post-consumer + ½ pre-consumer)	1
		1	Credit 4.2	**Recycled Content:** 20% (post-consumer + ½ pre-consumer)	1
		1	Credit 5.1	**Regional Materials:** 10% Extracted, Processed & Manufactured Regionally	1
		1	Credit 5.2	**Regional Materials:** 20% Extracted, Processed & Manufactured Regionally	1
			Credit 6	**Certified Wood**	1
Likely	Poss.	Contr.			
2			**Indoor Environmental Quality**		**11** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
			Credit 1	**Outdoor Air Delivery Monitoring**	1
			Credit 2	**Increased Ventilation**	1
			Credit 3	**Construction IAQ Management Plan:** During Construction	1
			Credit 4.1	**Low-Emitting Materials:** Adhesives & Sealants	1
			Credit 4.2	**Low-Emitting Materials:** Paints & Coatings	1
			Credit 4.3	**Low-Emitting Materials:** Carpet Systems	1
			Credit 4.4	**Low-Emitting Materials:** Composite Wood & Agrifiber Products	1
			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6	**Controllability of Systems:** Thermal Comfort	1
			Credit 7	**Thermal Comfort:** Design	1
1			Credit 8.1	**Daylight & Views:** Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views:** Views for 90% of Spaces	1
Likely	Poss.	Contr.			
	1		**Innovation & Design Process**		**5** Points
	1		Credit 1.1	**Innovation in Design**: Provide Specific Title	1
			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
			Credit 1.3	**Innovation in Design**: Provide Specific Title	1
			Credit 1.4	**Innovation in Design**: Provide Specific Title	1
			Credit 2	**LEED® Accredited Professional**	1
Likely	Poss.	Contr.			
10	3	4	**Totals (pre-certification estimates)**		61

Certified: 23 to 27 points, **Silver:** 28 to 33 points, **Gold:** 34 to 44 points, **Platinum:** 45 to 61 points



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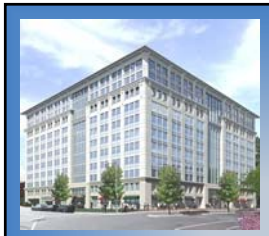
Potential LEED Status



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Existing LEED Status

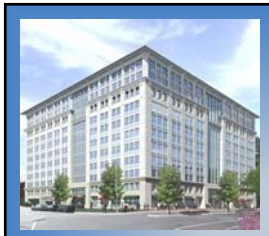
LEED® Green Building Rating System™ For Core & Shell Development, v2.0

- **Sustainable Sites (SS)**
  - 1.0 Site Selection
  - 2.0 Development Density & Community Connectivity
  - 4.1 Public Transportation
  - 7.1 Heat Island Effect, Non-Roof
- **Water Efficiency (WE)**
  - 5 Possible Points
- **Energy & Atmosphere (EA)**
  - 14 Possible Points
- **Materials & Resources (MR)**
  - 11 Possible Points
- **Indoor Environmental Quality (EQ)**
  - 8.1 Daylight & Views: Daylight 75% of Spaces
  - 8.2 Daylight & Views: Views for 90% of Spaces
- **Innovation & Design Process (ID)**
  - 5 Possible Points

LEED® Accreditation:

4 Points Achieved

2 Points Possible



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Potential LEED Status

LEED® Green Building Rating System™ For Core & Shell Development, v2.0

Sustainable Sites (SS)
1.0 Site Selection
2.0 Development Density & Community Connectivity
4.1 Public Transportation
6.1 Storm Water Design: Quantity Control
7.1 Heat Island Effect, Non-Roof
7.2 Heat Island Effect, Roof

Water Efficiency (WE)
1.1 Water Efficient Landscaping: Reduce by 50%

Energy & Atmosphere (EA)
1.0 Optimize Energy Performance

Materials & Resources (MR)
4.1, 4.2 Recycled Content
5.1, 5.2 Regional Materials

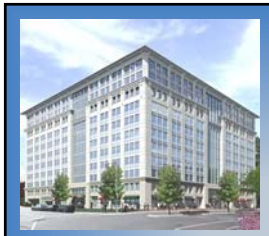
Indoor Environmental Quality (EQ)
8.1 Daylight & Views: Daylight 75% of Spaces
8.2 Daylight & Views: Views for 90% of Spaces

Innovation & Design Process (ID)
1.1 Innovation in Design

LEED® Accreditation:

10 Points Achieved

7 Points Possible



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Acknowledgements

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Dr. John Messner
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Sika Sarnafil Ryan Shaughnessy

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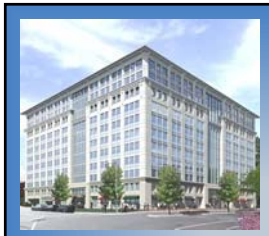

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Questions