10. LEED RATING EVALUATION

In order to quantify the "green-ness" of a building, the United States Green Building Council (USGBC) utilizes a point system for sustainable design elements. The total points a building earns can receive a LEED Rating of Certified (26-32 points), Silver (33-38 points), Gold (39-51 points), or Platinum (greater than 51 points) (LEED). The SLCC is designed to LEED-NC v2.1 Standards. This section will evaluate the existing and proposed design with respect to this rating system.

10.1. ORIGINAL DESIGN RATING

A preliminary LEED analysis of the project design was conducted by the primary architect SmithGroup (Table 10.1). It is important to note that this facility has not gone through the LEED Submittal and Review Process and thus this analysis is not an official rating by the USGBC. Also, assumptions were made on several "maybe" points such as ID Credit 1. Here, innovation points were assumed to be garnered for an "educational case study" of visucentric design and for exceeding the recycled content requirement by at least 25%.

LEED™ Scorecard - Gallaudet University - SLCC

Y	?	N			
28	4	37	**Total Project Score**	Possible Points	69

Certified 26 to 32 points **Silver** 33 to 38 points **Gold** 39 to 51 points **Platinum** 52 or more points

Y	?	N			
6	1	7	**Sustainable Sites**	Possible Points	14
Y			Prereq 1	**Erosion & Sedimentation Control**	
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Urban Redevelopment**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
		1	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
1			Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
		1	Credit 8	**Light Pollution Reduction**	1

Y	?	N			
4		1	**Water Efficiency**	Possible Points	5
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Y	?	N			
3	2	12	**Energy & Atmosphere**	Possible Points	17
Y			Prereq 1	**Fundamental Building Systems Commissioning**	
Y			Prereq 2	**Minimum Energy Performance**	
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	
1	1		Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
		2	Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
		2	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
		2	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
		2	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
1			Credit 4	**Ozone Depletion**	1
		1	Credit 5	**Measurement & Verification**	1
	1		Credit 6	**Green Power**	1

Y	?	N			
6		7	**Materials & Resources**	Possible Points	13
Y			Prereq 1	**Storage & Collection of Recyclables**	
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1			Credit 2.1	**Construction Waste Management**, Divert 50%	1
1			Credit 2.2	**Construction Waste Management**, Divert 75%	1
		1	Credit 3.1	**Resource Reuse**, Specify 5%	1
		1	Credit 3.2	**Resource Reuse**, Specify 10%	1
1			Credit 4.1	**Recycled Content**, Specify 25%	1
1			Credit 4.2	**Recycled Content**, Specify 50%	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1

Y	?	N			
6	1	8	**Indoor Environmental Quality**	Possible Points	15
Y			Prereq 1	**Minimum IAQ Performance**	
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	
		1	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
		1	Credit 2	**Increase Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	1		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		1	Credit 6.1	**Controllability of Systems**, Perimeter	1
		1	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
		1	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
		1	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
		1	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Y	?	N			
3		2	**Innovation & Design Process**	Possible Points	5
1			Credit 1.1	**Innovation**: Educational Case Study	1
		1	Credit 1.2	**Innovation**: Exceed Water Use Reduction by an additional 10%	1
1			Credit 1.3	**Innovation in Design**: Exceed Recycled content by an additional 25%	1
		1	Credit 1.4	**Innovation in Design**: Process Load Reduction	1
1			Credit 2	**LEED™ Accredited Professional**	1

Table 10.1: LEED Scorecard for original SLCC design.

The results of this LEED analysis show that the project expects to earn 28 points and thus a "LEED Certified" Rating. The point for Sustainable Sites Credit 7.2 for reducing the urban heat island effect is expected to be earned because the original design includes a highly reflective "cool roof." Some notable credits where points are not earned are the Sustainable Sites Credit 6.1 and at least eight (8) of ten (10) Energy and Atmosphere Credits (EA CR 1.1-1.5).

10.1.1. SUSTAINABLE SITES CREDIT 6.1

The intent for LEED-NC v2.1 SS CR 6.1 is to "limit disruption and pollution of natural water flows by managing stormwater runoff." In order to gain a point for this credit one of two requirements must be met: if the existing site is greater than 50% impervious by area, the post-construction site must have at least 25% less impervious area; if the existing site is less than 50% impervious by area, the post-construction site impervious area must not exceed that of the original site (LEED).

The calculations for the Sustainable Sites Credit 6.1 for the actual site design may be found in Table 10.2 below. The undeveloped site has over 65% impervious surface area so the post-construction site must have 25% less impervious area. These results show that the actual site design increases the impervious area of the site. While pavement area is reduced from the original site, the building (primarily the roof) increases the impervious area. Therefore this credit is not earned for the actual site design.

Annual Site Stormwater Runoff

	Runoff Coefficient	Undeveloped Site			Actual Design		
		Area [SF]	% of Site	Runoff [CF]	Area [SF]	% of Site	Runoff [CF]
Total Pervious:	0.00	26665	34.4%	0	13260	17.1%	0
Total Impervious:	1.00	50935	**65.6%**	163968	64340	**82.9%**	207121
TOTAL		77600		**163968**	77600		**207121**

Percent Reduction in Pervious Area = **-26.3%**

LEED Points earned = **0**

Table 10.2: Sustainable Sites Credit 6.1 calculation for original SLCC design.

10.1.2. ENERGY & ATMOSPHERE CREDIT 1

The LEED-NC v2.1 EA Credit 1 is intended to "achieve increasing levels of energy performance above the prerequisite standard (ASHRAE Std. 90.1-1999) to reduce environmental impacts associated with excessive energy use" (LEED). Points are awarded for reducing the design energy cost relative to the energy cost budget for energy systems regulated by ASHRAE Std. 90.1-1999. For new buildings one (1) point is earned for a 15% reduction in annual energy cost, and an additional point is awarded for each 5% greater reduction up to ten (10) points for a 60% energy cost reduction.

The calculations for the energy budget case and original annual energy cost for EA CR 1 may be found in Table 10.3 and Table 10.4 on below, and the LEED points earned can be seen in Table 10.5 on page 59.

Budget Case Data (Per ASHRAE Std. 90.1-1999)

End Use	Energy Type	Electric [kWh]	Oil [kBtu]	Energy Use [10^3 Btu]	Annual Cost
Regulated					
Lighting	Electric	304,679		1,039,565	$27,543
Space Heating	Oil		756,460	756,460	$10,477
Space Heating	Electric				
Space Cooling	Electric			2,458,524	$65,138
Fans / Pumps	Electric	225,330		768,826	$20,370
Hot Water	Oil		300,750	300,750	$4,165
Subtotal Regulated (ECB')		530,009	1,057,210	5,324,125	$127,693
Non-Regulated					
Receptacles	Electric	978,965		3,340,229	$25,937
Space Heating	Oil		15,030	15,030	$208
Space cooling	Electric		1,294,311	1,294,311	$34,292
Fans / Pumps	Electric	23155		79,005	$2,093
Subtotal Non-Regulated		1,002,120	1,309,341	4,728,574	$62,531
Total Building		1,532,129	2,366,551	10,052,699	$190,224
ECB''				5,324,125	**$127,693**

Table 10.3: Energy cost budget for the SLCC.

Design Case LEED-NC EA CR 1 Summary (Cool Roof, VAV System)

End Use	Energy Type	Electric [kWh]	Oil [kBtu]	Energy Use [10^3 Btu]	Annual Cost
Regulated					
Lighting	Electric	223,695		763,246	$20,222
Space Heating	Oil		74,957	74,957	$1,038
Space Heating	Electric				
Space Cooling	Electric			2,167,121	$57,417
Fans / Pumps	Electric	176,864		603,461	$15,989
Subtotal Regulated (DEC')		400,559	74,957	3,608,785	$94,666
Non-Regulated					
Receptacles	Electric	978,965		3,340,229	$23,381
Space Heating	Oil		15,030	15,030	$199
Space cooling	Electric		1,294,311	1,294,311	$32,757
Fans / Pumps	Electric	23155		79,005	$1,999
Subtotal Non-Regulated		1,002,120	1,309,341	4,728,574	$58,336
Total Building		1,402,679	1,384,298	8,337,359	$153,002
DEC''				3,608,785	**$94,666**

Table 10.4: Annual energy costs of regulated, unregulated energy.

Design Case LEED-NC CR 7.1 Summary (Cool Roof, VAV System)

Energy & Cost Summary by Fuel	DEC'' Use [10^3 Btu]	DEC'' Cost [$]	ECB' Use [10^3 Btu]	ECB' Cost [$]	DEC'' / ECB' Energy %	DEC'' / ECB' Cost %
Electricity	3,533,828	$93,628	4,266,915	$113,051	82.8%	82.8%
Oil	74,957	$1,038	1,057,210	$14,642	7.1%	7.1%
Total	**3,608,785**	**$94,666**	**5,324,125**	**$127,693**		

Percent Savings = 100 x (ECB' $ - DEC'' $) / ECB' $ = 25.9%

Credit 1 Points Earned = 1

Credit 1 Points Possibly Earned = 1

Table 10.5: LEED-NC v2.1 Energy and Atmosphere Credit 1 calculation for original SLCC design.

These results confirm that the building energy use is expected to be about 25% less than the energy cost budget model. Because the second point of ES CR 1.1 requires at least a 25% reduction in energy this credit may or may not be earned. The submittal, review, and commissioning process would likely determine whether this point is earned or not.

10.2. PROPOSED DESIGN RATING

The proposals for this thesis should earn some of these points that were not counted towards the original design. The DOAS system alone saves significant energy and could earn five (5) and possibly six (6) EA Credit 1 points. The green roof and pervious pavement could also earn the SS Credit 6.1 point, and would help ensure the sixth EA Credit 1 point.

As a result, the proposed DOAS mechanical system in tandem with the proposed extensive green roof and new pavement will likely change the LEED Rating of the SLCC from Certified to Silver (Table 10.6).

LEED™ Scorecard - Gallaudet University - SLCC (Proposed Design)

Y	?	N			
34	4	31	**Total Project Score**	Possible Points	69

Certified 26 to 32 points **Silver** 33 to 38 points **Gold** 39 to 51 points **Platinum** 52 or more points

Y	?	N			
7	1	6	**Sustainable Sites**	Possible Points	14
Y			Prereq 1	**Erosion & Sedimentation Control**	
1			Credit 1	**Site Selection**	1
		1	Credit 2	**Urban Redevelopment**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
		1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
	1		Credit 4.4	**Alternative Transportation**, Parking Capacity	1
		1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
1			Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
1			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
		1	Credit 8	**Light Pollution Reduction**	1

Y	?	N			
4		1	**Water Efficiency**	Possible Points	5
1			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1			Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Y	?	N			
8	1	8	**Energy & Atmosphere**	Possible Points	17
Y			Prereq 1	**Fundamental Building Systems Commissioning**	
Y			Prereq 2	**Minimum Energy Performance**	
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	
2			Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
2			Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
2			Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
		2	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
		2	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
1			Credit 4	**Ozone Depletion**	1
		1	Credit 5	**Measurement & Verification**	1
	1		Credit 6	**Green Power**	1

Y	?	N			
6		7	**Materials & Resources**	Possible Points	13
Y			Prereq 1	**Storage & Collection of Recyclables**	
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1			Credit 2.1	**Construction Waste Management**, Divert 50%	1
1			Credit 2.2	**Construction Waste Management**, Divert 75%	1
		1	Credit 3.1	**Resource Reuse**, Specify 5%	1
		1	Credit 3.2	**Resource Reuse**, Specify 10%	1
1			Credit 4.1	**Recycled Content**, Specify 25%	1
1			Credit 4.2	**Recycled Content**, Specify 50%	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1

Y	?	N			
6	1	8	**Indoor Environmental Quality**	Possible Points	15
Y			Prereq 1	**Minimum IAQ Performance**	
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	
		1	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
		1	Credit 2	**Increase Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	1		Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		1	Credit 6.1	**Controllability of Systems**, Perimeter	1
		1	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
		1	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
		1	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
		1	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
		1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Y	?	N			
3	1	1	**Innovation & Design Process**	Possible Points	5
1			Credit 1.1	**Innovation**: Educational Case Study	1
	1		Credit 1.2	**Innovation**: Exceed Water Use Reduction by an additional 10%	1
1			Credit 1.3	**Innovation in Design**: Exceed Recycled content by an additional 25%	1
		1	Credit 1.4	**Innovation in Design**: Process Load Reduction	1
1			Credit 2	**LEED™ Accredited Professional**	1

Table 10.6: LEED Scorecard for SLCC with green roof and DOAS system designs.

10.2.1. ENERGY AND ATMOSPHERE CREDIT 1

The DOAS system in combination with the original cool roof produces an expected total energy cost savings of $24,344/yr. Table 10.7 shows the difference between regulated and unregulated costs that factor into Table 10.8.

Design Case LEED-NC EA CR 1 Summary (Green Roof, DOAS System)

End Use	Energy Type	Electric [kWh]	Oil [kBtu]	Energy Use [10^3 Btu]	Cost
Regulated					
Lighting	Electric	223,053		761,057	$20,164
Space Heating	Oil		24,233	24,233	$336
Space Heating	Electric				
Space Cooling	Electric			1,544,992	$40,934
Fans / Pumps	Electric	103,556		353,333	$9,361
Subtotal Regulated (DEC')		326,609	24,233	2,683,616	$70,795
Non-Regulated					
Receptacles	Electric	978,965		3,340,229	$23,226
Space Heating	Oil		15,030	15,030	$158
Space cooling	Electric		1,294,311	1,294,311	$26,090
Fans / Pumps	Electric	23155		79,005	$1,593
Subtotal Non-Regulated		1,002,120	1,309,341	4,728,574	$51,067
Total Building		1,328,729	1,333,574	7,412,190	$121,862
DEC''				2,683,616	**$70,795**

Table 10.7: Summary of energy use in the SLCC for the DOAS system and green roof.

Design Case LEED-NC EA CR 1 Summary (Green Roof, DOAS System)

Energy & Cost Summary by Fuel	DEC'' Use [10^3 Btu]	DEC'' Cost [$]	ECB' Use [10^3 Btu]	ECB' Cost [$]	DEC'' / ECB' Energy %	DEC'' / ECB' Cost %
Electricity	2,659,383	$70,460	4,266,915	$113,051	62.3%	62.3%
Oil	23,595	$327	1,057,210	$14,642	2.2%	2.2%
Total	**2,682,978**	**$70,786**	**5,324,125**	**$127,693**		

Percent Savings = 100 x (ECB' $ - DEC'' $) / ECB' $ = 44.6%

Credit 1 Points Earned = 6

Credit 1 Points Possibly Earned = 0

Table 10.8: EA Credit 1 points earned with DOAS system and green roof.

10.2.2. SUSTAINABLE SITES CREDIT 6.1

The addition of the green roof has a significant impact on the amount of stormwater drained from the SLCC site. It accounts for an approximately 25% reduction of impervious area compared to the original SLCC design with the cool roof (Table 6.4) and an approximately 5% reduction of impervious area compared to the pre-construction site. This is not enough, however, to earn the LEED SS CR 6.1 Point as there needs to be a 25% reduction in impervious area on the site compared to the pre-construction site. This can be achieved by replacing the parking pavement with pervious concrete (Figure 10.1), thus earning the LEED point (Table 10.9). The total reduction in impervious area can be improved to over 42% if all stormwater drainage from the roof is captured and used to water the roof (Table 10.10). This could potentially be worthy of an Innovation & Design Credit point, but this LEED analysis conservatively assumes that this point would not be awarded.

Figure 10.1: Pervious concrete.

Annual Site Stormwater Runoff

	Runoff Coefficient	Undeveloped Site		Green Roof, Perv. Parking		
		Area [SF]	Runoff [CF]	Area [SF]	% of Total	Runoff [CF]
Total Pervious:	0.00	26665	0	44430	57.3%	0
Total Impervious:	1.00	50935	163968	33171	**42.7%**	106781
TOTAL		77600	**163968**	77600		**122427**

Percent Reduction in Pervious Area = **25.3%**
LEED Points earned = **1**

Table 10.9: Sustainable Sites Credit 6.1 calculation for green roof, pervious parking.

Annual Site Stormwater Runoff

	Runoff Coefficient	Undeveloped Site		Green Roof, Perv. Parking		
		Area [SF]	Runoff [CF]	Area [SF]	% of Total	Runoff [CF]
Asphalt/Concrete:	0.95	42550	130127	22260	28.7%	68076
Pervious Concrete	0.60	0	0	8100	10.4%	15645
Building (roof):	0.00	0	0	9130	11.8%	0
Grass:	0.25	28050	22574	13400	17.3%	10784
Green Roof:	0.00	0	0	24710	31.8%	0
Other:	0.50	7000	11267	0	0.0%	0
Total Pervious:	0.00	26665	0	53103	68.4%	0
Total Impervious:	1.00	50935	163968	24497	**31.6%**	78860
TOTAL		77600	**163968**	77600		**94505**

Percent Reduction in Pervious Area = **42.4%**
LEED Points earned = **1**
LEED Points possibly earned = **1**

Table 10.10: Sustainable Sites Credit 6.1 calculation for proposed design and stormwater reuse.