IHS – LEED Cost Evaluation Study

Division of Engineering Services

IHS Facility Managers Workshop
Rapid City, SD
September, 2006

LEED Cost Evaluation Study (Excerpts)

Cover Page

Executive Summary

Table 2-2 (Credit Groupings)

Example Individual Credit Review Sheet

Table 4-1 (Cost Estimate for LEED Certification using Sisseton)

Table 4-2 (Summary Comparison – GSA vs. IHS LEED Studies)

LEED Cost Analysis (Alaska – Arctic Conditions)

LEED Cost Evaluation Study

August 17, 2006

Supersedes June 21, 2006 Edition

Department of Health and Human Services
Indian Health Service
Division of Engineering Services

Executive Summary

Background

The Indian Health Service (IHS) is responsible for the design and construction of numerous health care facilities throughout the United States. These facilities differ tremendously in terms of size, location, cost, and performance. It is the intention of the IHS to pursue concepts of sustainable design in compliance with the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding, the Energy Policy Act of 2005 (EPAct), and the pending DHHS Policy for Development and Operation of Sustainable, High Performance Facilities.

The simplest path to compliance with guidelines may include successful certification of IHS facilities with the U.S. Green Building Council's (USGBC) LEED® (Leadership in Energy & Environmental Design) rating system for new construction. However, the cost impacts of achieving LEED certification on IHS facilities have not yet been established.

Purpose

The purpose of this report is to evaluate the potential cost impacts of achieving Basic and/or Silver LEED certification on IHS facilities. Both initial capital investment costs and life-cycle costs (LCC) have been evaluated. This study is intended to develop realistic cost factors for the implementation of LEED certification that can be included in the IHS Facility Budget Estimating System (FBES) so that projects can be adequately funded for this purpose. Although each LEED Credit has been evaluated and grouped according to feasibility, there is no intent to prescribe a specific path of LEED credits toward certification. Every project will need to be evaluated on the basis of its program, location, and operation to determine the optimum path toward LEED certification.

Methodology

For the purposes of this study, a specific path has been chosen and certain assumptions made in order to define costs. In all cases, LEED credits have been evaluated against IHS standard practices as outlined in the A/E Design Guide. For estimation of quantities, the Sisseton Ambulatory Care Facility, currently under construction in Sisseton, SD has been utilized as a representative IHS Health Care Facility. All evaluation factors are described in greater detail within the body of the report.

Findings

The following tables identify the cost impacts for Basic and Silver LEED certification:

Initial Capital Construction Cost (does not include LCC)

	Certified		Silver	
	Low	High	Low	High
LEED Construction Cost Impacts				
Cost Impact	$170,700	$507,900	$589,700	$1,268,500
$/GSF	$2.01	$5.98	$6.95	$14.94
% Change	1.0%	3.0%	3.5%	7.6%

Table ES-1: Summary of Construction Cost Impacts

The data in table ES-1 contains costs, which would be added to the conventional construction cost. (The baseline construction cost estimate for the Sisseton ACF is $197 per square foot as designed).

Life Cycle Cost (does not include Capital Cost)

	Certified		Silver	
	Low	High	Low	High
LEED Life Cycle Cost Impacts*				
20-yr Life Cycle Cost Impacts	$ (133,300)	$ 150,500	$ (183,400)	$ 118,500
$/GSF	$ (1.57)	$ 1.77	$ (2.16)	$ 1.40

* Numbers shown in parenthesis indicate a negative life cycle cost impact, i.e. net savings as opposed to costs.

Table ES-2: Summary of 20-year Life Cycle Cost Impacts

For the purposes of this study, the life cycle cost impacts were calculated, based on a 20-year cycle. Although IHS facilities are designed for a life cycle, which exceeds this 20-year period, this study did not presume to project cost impacts beyond this duration.

Aggregate Cost (Capital and Life Cycle Cost combined)

	Certified		Silver	
	Low	High	Low	High
Aggregate Life Cycle Cost Impacts				
$/GSF	$0.44	$7.76	$4.79	$16.34
% Change	0.2%	3.9%	2.4%	8.3%

Table ES-3: Summary of Aggregate Cost Impacts

An examination of the three preceding tables suggests that energy savings over the life cycle of a facility have the potential to significantly mitigate the initial capital cost impacts. Given the potential margin of error inherent in these types of calculations, and the uncertainty of future energy prices, life cycle cost savings may completely offset or even exceed initial capital costs. As can be seen in Appendix C (Detailed Life Cycle Cost Estimates), for Credit EA1 – *Optimize Energy Performance*, the methodology used to calculate future energy costs and associated life cycle cost savings is extremely conservative.

Review of Individual Credits

To summarize the research conducted on each credit and prerequisite (65 total,) individual credit reviews are provided in this report. Each credit review sheet contains data regarding feasibility assessments, cost impact, life cycle cost impact, intent of the individual credit or prerequisite, relevant requirements, and other considerations. Additional detail regarding cost estimates, credit interpretation requests, and design calculations are contained in the appendix.

Recommendations

It is advisable for IHS to adopt LEED certification in pursuit of sustainable design and adjust project budgets accordingly. Doing so provides a measurable benchmark for determining success. LEED is widely known, has significant credibility within the private and public sectors, provides third-party validation and provides recognition for the agency, affiliated tribes, and communities. Flexibility in the LEED process facilitates multiple avenues for achieving a basic certification under disparate circumstances, site conditions, and geographic locations. Based on the analysis summarized above a 3.0% increase to the project budget is appropriate to pursue a basic LEED certification.

Summary of IHS LEED® Credit Groupings

		Capital Cost Impact		LCC Impact		Pts	Langdon
		Low	High	Low	High		Study
Tier 1: Prerequisites							
SSPR1	Construction Activity Pollution Prevention	$0	$0	$0	$0	-	-
EAPR1	Fundamental Commissioning of the Building Energy Systems	$18,000	$22,000	$0	$0	-	-
EAPR2	Minimum Energy Performance	$0	$0	$0	$0	-	-
EAPR3	Fundamental Refrigerant Management	$0	$0	$0	$0	-	-
MRPR1	Storage & Collection of Recyclables	$0	$46,000	$5,700	$70,500	-	-
EQPR1	Minimum IAQ Performance	$0	$0	$0	$0	-	-
EQPR2	Environmental Tobacco Smoke (ETS) Control	$0	$0	$0	$0	-	-
	Total, Prerequisites:	**$18,000**	**$68,000**	**$5,700**	**$70,500**	-	
Tier 2: Mandate or Standard Practice							
EA1(1)	Optimize Energy Performance (First Two Points; See Note 2. Below)	$0	$0	$0	$0	2	94%
EQ7.1	Thermal Comfort, Design	$0	$0	$0	$0	1	78%
ID2	LEED® Accredited Professional	$0	$0	$0	$0	1	97%
WE1.1	Water Efficient Landscaping, Reduce by 50%	$7,900	$13,100	$9,200	$21,000	1	83%
WE1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	$0	$45,000	-$21,900	$48,200	1	16%
	Total, Mandate or Standard Practice:	**$7,900**	**$58,100**	**-$12,700**	**$69,200**	**6**	**74%**
Tier 3: High Feasibility							
EA1(2)	Optimize Energy Performance (Points 3-5; See Note 2. Below)	$20,000	$40,000	-$82,800	-$61,200	3	50%
SS4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	$0	$1,200	$0	$0	1	80%
SS4.4	Alternative Transportation, Parking Capacity	$0	$0	$0	$0	1	58%
EQ4.1	Low-Emitting Materials, Adhesives & Sealants	$0	$1,600	$0	$0	1	100%
EQ4.2	Low-Emitting Materials, Paints & Coatings	$0	$21,100	$0	$0	1	95%
EQ4.3	Low-Emitting Materials, Carpet Systems	$0	$14,300	$0	$0	1	91%
SS7.2	Heat Island Effect, Roof	$22,500	$27,500	-$9,200	-$5,500	1	42%
ID1.4	Innovation in Design: SS7.2-SRI 78 for 100% of roof surface	$0	$0	$0	$0	1	0%
SS8	Light Pollution Reduction	$0	$13,000	$0	$0	1	61%
EA5	Measurement & Verification	$3,000	$8,000	$3,700	$15,000	1	24%
EQ1	Outdoor Air Delivery Monitoring	$3,000	$3,600	$700	$1,200	1	52%
EQ2	Increased Ventilation	$2,000	$5,000	$14,300	$47,700	1	16%
EQ3.1	Construction IAQ Management Plan, During Construction	$300	$1,500	$0	$0	1	95%
EQ3.2	Construction IAQ Management Plan, Before Occupancy	$1,000	$3,000	$0	$0	1	88%
EQ5	Indoor Chemical & Pollutant Source Control	$1,300	$11,000	$1,200	$2,500	1	64%
EQ6.1	Controllability of Systems, Lighting	$0	$10,000	$0	$0	1	25%
EQ7.2	Thermal Comfort, Verification	$0	$0	$1,000	$2,000	1	24%
	Total, High Feasibility:	**$53,100**	**$160,800**	**-$71,100**	**$1,700**	**19**	**59%**
Tier 4: Moderate Feasibility							
EA1(3)	Optimize Energy Performance (Points 6-7; See Note 2. Below)	$30,000	$60,000	-$55,200	-$40,800	2	20%
SS6.1	Stormwater Design, Quantity Control	$0	$83,500	$0	$49,900	1	34%
SS7.1	Heat Island Effect, Non-Roof	$120,000	$143,400	-$11,800	-$7,100	1	62%
EA3	Enhanced Commissioning	$16,700	$22,500	$0	$0	1	43%
EQ4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	$0	$159,900	$0	$0	1	41%
EA4	Enhanced Refrigerant Management	$5,000	$20,000	$5,600	$7,500	1	58%
MR4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	$0	$27,900	$0	$0	1	94%
MR5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally	$0	$50,000	$0	$0	1	97%
EA2(1)	On-Site Renewable Energy (First Two Points)	$294,000	$359,400	-$43,900	-$32,400	2	8%
	Total, Moderate Feasibility:	**$465,700**	**$926,600**	**-$105,300**	**-$22,900**	**11**	**56%**

		Capital Cost Impact		LCC Impact		Pts	Langdon
		Low	High	Low	High		Study
Tier 5: Low Feasibility							
EA1(4)	Optimize Energy Performance (Points 8-10; See Note 2. Below)	-	-	-$82,800	-$61,200	3	0%
WE3.1	Water Use Reduction, 20% Reduction	-	-	-	-	1	80%
WE2	Innovative Wastewater Technologies	$43,000	$53,000	$58,000	$71,000	1	5%
WE3.2	Water Use Reduction, 30% Reduction	-	-	-	-	1	10%
MR3.1	Materials Reuse, 5%	-	-	$0	$0	1	3%
MR4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)	-	-	$0	$0	1	17%
MR5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally	-	-	$0	$0	1	3%
MR6	Rapidly Renewable Materials	-	-	-	-	1	8%
MR7	Certified Wood	-	-	$0	$0	1	30%
EQ6.2	Controllability of Systems, Thermal Comfort	-	-	-	-	1	4%
EQ8.1	Daylight & Views, Daylight 75% of Spaces	-	-	-	-	1	33%
EQ8.2	Daylight & Views, Views for 90% of Spaces	-	-	$0	$0	1	53%
ID1.3	Innovation in Design: SS7.1-100% Hardscape meets requirements	$240,000	$286,800	-$11,800	-$7,100	1	7%
MR3.2	Materials Reuse,10%	-	-	$0	$0	1	0%
MR2.1	Construction Waste Management, Divert 50% from Disposal	-	-	$0	$0	1	100%
MR2.2	Construction Waste Management, Divert 75% from Disposal	-	-	$0	$0	1	72%
EA2(2)	On-Site Renewable Energy (Final Point)	-	-	-	-	1	0%
	Total, Low Feasibility:	**$283,000**	**$339,800**	**-$36,600**	**$2,700**	**19**	**25%**
Tier 6: Situational							
SS1	Site Selection	$24,000	$105,000	$0	$0	1	84%
SS2	Development Density & Community Connectivity	-	-	$0	$0	1	8%
SS4.1	Alternative Transportation, Public Transportation Access	-	-	$0	$0	1	75%
SS5.2	Site Development, Maximize Open Space	$0	$0	$0	$0	1	34%
ID1.2	Innovation in Design: SS5.2-Provide 2x Bldg Footprint as open space	$0	$0	$0	$0	1	30%
SS3	Brownfield Redevelopment	$44,000	$330,000	$0	$143,300	1	3%
SS6.2	Stormwater Design, Quality Control	$70,000	$124,300	$0	$27,800	1	46%
SS5.1	Site Development, Protect of Restore Habitat	$0	$21,000	$0	$0	1	36%
ID1.1	Innovation in Design: SS5.1-Restore 75% of Site	$18,000	$21,000	$0	$0	1	66%
MR1.1	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	-	-	$0	$0	1	5%
MR1.2	Building Reuse, Maintain 100% of Existing Walls, Floors & Roof	-	-	$0	$0	1	3%
MR1.3	Building Reuse, Maintain 50% of Interior Non-Structural Elements	-	-	$0	$0	1	0%
	Total, Situational:	$156,000	$601,300	$0	$171,100	12	33%
Tier 7: Non-Construction							
SS4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles	$21,000	$26,000	-$18,600	$0	1	10%
EA6	Green Power	-	-	-	-	1	7%
	Total, Non-Construction:	$21,000	$26,000	-$18,600	$0	2	9%

Notes

1. "Langdon Study" refers to a study, which referenced the frequency of building projects achieving a particular credit, when pursuing a LEED "certified" level

2. The Energy Policy Act of 2005 will promulgate energy practices within IHS, to exceed ASHRAE 90.1 by 30%. This will earn six points for this LEED credit. For the purposes of this study however, the credits are divided into different tiers (more conservative.)

Summary of First Four Tiers (as a % of total Construction Cost)	Cap. Cost Range		% of Tot.	Points
Prerequisites	$18,000	$68,000	0.1 to 0.4	0
Mandate or Standard Practice	$7,900	$58,100	0.0 to 0.3	6
High Feasibility	$53,100	$160,800	0.3 to 1.0	19
Moderate Feasibility	$465,700	$926,600	2.8 to 5.5	11
Total	**$544,700**	**$1,213,500**	**3.3 to 7.2**	**36**

Table 2-2: Credit Categorization Matrix, including Capital and Life Cycle Cost Impacts

Indoor Environmental Quality Credit 4.1: Low-Emitting Materials, Adhesives & Sealants

Feasibility: High.

Initial Cost Impact: Moderate.

Mandate or Standard Practice	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Life-Cycle Cost Impact: None or Insignificant.

Potential Savings	**$0 - $5K**	$5K - $50K	$50K - $150K	>$150K

Intent: Reduce quantity of potentially harmful indoor air contaminants.

Relevant Requirements: Specify interior adhesives and sealants with VOC contents meeting South Coast Air Quality Management District Rule #1168 and Bay Area Air Quality Management District Regulation 8, Rule 51.

GSA Study Conclusions: No premium – Many compliant products available.

Other Considerations: Anecdotal information available that low VOC products do not perform well.

Cost Estimates:

Capital Cost: $0 - $1,600

Life Cycle Cost: None

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

IHS Evaluation Project - Sisseton

C	S			Points Possible	Points Earned C	Points Earned S	Capital Cost Impacts: Basic Certification Low	Basic Certification High	Silver Certification Low	Silver Certification High
0	0	**Sustainable Sites**		14 Points	5	6	$22,500	$125,200	$142,500	$268,600
✓	✓	Prereq 1	**Construction Activity Pollution Prevention**	Required			$0	$0	$0	$0
		Credit 1	**Site Selection**	1						
		Credit 2	**Development Density & Community Connectivity**	1						
		Credit 3	**Brownfield Redevelopment**	1						
		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1						
✓	✓	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	1	1	$0	$1,200	$0	$1,200
		Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1						
✓	✓	Credit 4.4	**Alternative Transportation**, Parking Capacity	1	1	1	$0	$0	$0	$0
		Credit 5.1	**Site Development,** Protect of Restore Habitat	1						
		Credit 5.2	**Site Development,** Maximize Open Space	1						
✓	✓	Credit 6.1	**Stormwater Design,** Quantity Control	1	1	1	$0	$83,500	$0	$83,500
		Credit 6.2	**Stormwater Design,** Quality Control	1						
	✓	Credit 7.1	**Heat Island Effect,** Non-Roof	1		1			$120,000	$143,400
✓	✓	Credit 7.2	**Heat Island Effect,** Roof	1	1	1	$22,500	$27,500	$22,500	$27,500
✓	✓	Credit 8	**Light Pollution Reduction**	1	1	1	$0	$13,000	$0	$13,000
0	0	**Water Efficiency**		5 Points	2	2	$7,900	$58,100	$7,900	$58,100
✓	✓	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	1	1	$7,900	$13,100	$7,900	$13,100
✓	✓	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	1	1	$0	$45,000	$0	$45,000
		Credit 2	**Innovative Wastewater Technologies**	1						
		Credit 3.1	**Water Use Reduction**, 20% Reduction	1						
		Credit 3.2	**Water Use Reduction**, 30% Reduction	1						
0	0	**Energy & Atmosphere**		17 Points	9	12	$87,700	$152,500	$386,700	$531,900
✓	✓	Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required			$18,000	$22,000	$18,000	$22,000
✓	✓	Prereq 2	**Minimum Energy Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 3	**Fundamental Refrigerant Management**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Optimize Energy Performance**	1 to 10	7	7	$50,000	$100,000	$50,000	$100,000
	✓	Credit 2	**On-Site Renewable Energy**	1 to 3		2			$294,000	$359,400
✓	✓	Credit 3	**Enhanced Commissioning**	1	1	1	$16,700	$22,500	$16,700	$22,500
	✓	Credit 4	**Enhanced Refrigerant Management**	1		1			$5,000	$20,000
✓	✓	Credit 5	**Measurement & Verification**	1	1	1	$3,000	$8,000	$3,000	$8,000
		Credit 6	**Green Power**	1						
0	0	**Materials & Resources**		13 Points	0	2	$0	$46,000	$0	$123,900
✓	✓	Prereq 1	**Storage & Collection of Recyclables**	Required			$0	$46,000	$0	$46,000
		Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1						
		Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1						
		Credit 1.3	**Building Reuse**, Maintain 50% 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 3.1	**Materials Reuse**, 5%	1						
		Credit 3.2	**Materials Reuse**,10%	1						
	✓	Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1		1			$0	$27,900
		Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1						
	✓	Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regi	1		1			$0	$50,000
		Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regi	1						
		Credit 6	**Rapidly Renewable Materials**	1						
		Credit 7	**Certified Wood**	1						

C	S			Points Possible	Points Earned C	Points Earned S	Capital Cost Impacts: Basic Certification Low	Basic Certification High	Silver Certification Low	Silver Certification High
0	0	**Indoor Environmental Quality**		15 Points	11	12	$7,600	$71,100	$7,600	$231,000
✓	✓	Prereq 1	**Minimum IAQ Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Outdoor Air Delivery Monitoring**	1	1	1	$3,000	$3,600	$3,000	$3,600
✓	✓	Credit 2	**Increased Ventilation**	1	1	1	$2,000	$5,000	$2,000	$5,000
✓	✓	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1	1	1	$300	$1,500	$300	$1,500
✓	✓	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1	1	1	$1,000	$3,000	$1,000	$3,000
✓	✓	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1	1	1	$0	$1,600	$0	$1,600
✓	✓	Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1	1	1	$0	$21,100	$0	$21,100
✓	✓	Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1	1	1	$0	$14,300	$0	$14,300
	✓	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1		1			$0	$159,900
✓	✓	Credit 5	**Indoor Chemical & Pollutant Source Control**	1	1	1	$1,300	$11,000	$1,300	$11,000
✓	✓	Credit 6.1	**Controllability of Systems**, Lighting	1	1	1	$0	$10,000	$0	$10,000
		Credit 6.2	**Controllability of Systems**, Thermal Comfort	1						
✓	✓	Credit 7.1	**Thermal Comfort**, Design	1	1	1	$0	$0	$0	$0
✓	✓	Credit 7.2	**Thermal Comfort**, Verification	1	1	1	$0	$0	$0	$0
		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1						
		Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1						
0	0	**Innovation & Design Process**		5 Points	2	2	$0	$0	$0	$0
		Credit 1.1	**Innovation in Design**: SS5.1-Restore 75% of Site	1						
		Credit 1.2	**Innovation in Design**: SS5.2-Provide 2x Bldg Footprint as open space	1						
		Credit 1.3	**Innovation in Design**: SS7.1-100% Hardscape meets requirements	1						
✓	✓	Credit 1.4	**Innovation in Design**: SS7.2-SRI 78 for 100% of roof surface	1	1	1	$0	$0	$0	$0
✓	✓	Credit 2	**LEED® Accredited Professional**	1	1	1	$0	$0	$0	$0
0	0	**Project Totals** (pre-certification estimates)		69 Points	29	36	$125,700	$452,900	$544,700	$1,213,500
				+ Administrative Costs:			$45,000	$55,000	$45,000	$55,000
				TOTAL:			$170,700	$507,900	$589,700	$1,268,500
							1.0%	3.0%	3.5%	7.6%

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Table 4-1: Cost Estimate for Sisseton Ambulatory Care Facility

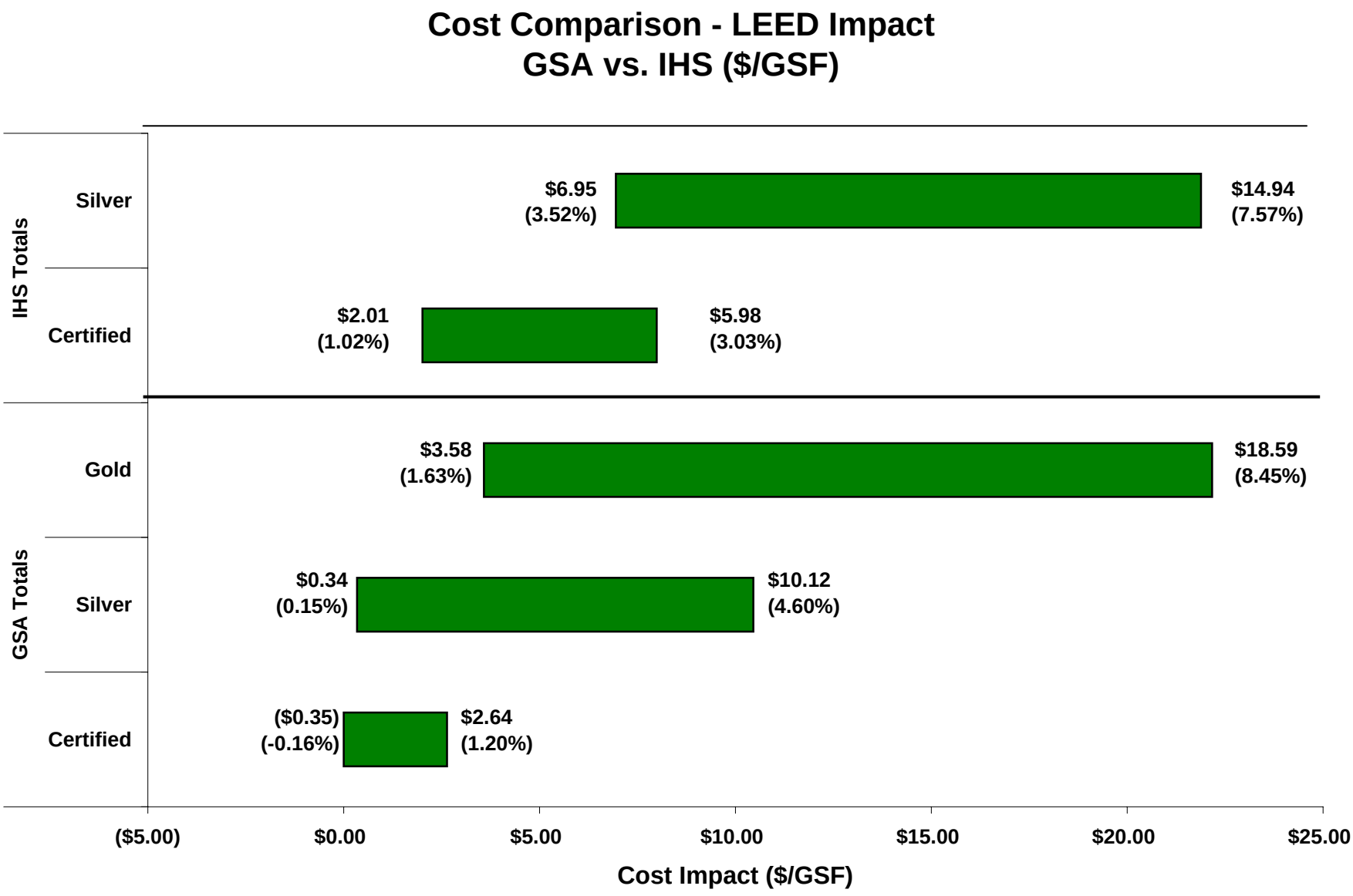


Figure 4-1: Cost Comparison between GSA and IHS LEED Studies

LEED Cost Analysis

Alaska – Arctic Conditions

August 16, 2006

Department of Health and Human Services
Indian Health Service
Division of Engineering Services

Introduction

In preparation for implementing sustainable design in IHS construction projects, the Division of Engineering Services performed a LEED Cost Evaluation Study. The final report of the LEED Cost Evaluation Study dated June 21, 2006 can be found on the DES website: http://www.des.ihs.gov.

Due to the diversity of climates, site conditions, facility functions, and other factors associated with IHS projects, the study did not attempt to simulate every possible construction scenario. Instead, it used the Sisseton Ambulatory Care Facility (currently under construction in Sisseton, SD) as a basis for the evaluation. By so doing, its results are representative of a facility constructed in the northern plains, having a rural setting, and a moderately sized cadre of health services.

Because a significant number of IHS facilities are constructed in the state of Alaska, the results of the study have been evaluated for application in arctic climates. The Barrow Replacement Hospital (currently in the Conceptual Design Phase) has been chosen as a basis for this evaluation.

Overview

This report contains a cost analysis for implementing LEED in the Alaskan environment for IHS facilities. It provides a summary of the most feasible credits to pursue, including cost impact factors, both for initial construction cost (i.e. capital cost,) and long-term operational and maintenance costs (i.e. life cycle cost.) Credits are totaled, sufficiently to obtain a Basic LEED Certification. These costs are summed, to develop a range of expected costs and potential savings. Where significant differences exist between the Sisseton and the Barrow facility, these are highlighted to emphasize issues unique to the Alaskan climate and environment.

This report is not as comprehensive as the initial study. It is simply an amendment to the original, utilizing the information from the Sisseton analysis to provide a basis for pursuing LEED Certification in Alaska.

The Barrow Replacement Hospital project will not be pursuing LEED Certification due to the timing of the design and other factors. However, the results of this investigation will be useful in determining budgetary and logistical hurdles to consider for future projects in this unique environment.

Summary of Credit Categories

Table 1 constitutes a modification of Table 2-2 from the LEED Cost Evaluation Study to reflect the Barrow Replacement Hospital conditions.

Summary of IHS LEED® Credit Groupings

		Capital Cost Impact		LCC Impact		
		Low	High	Low	High	Pts
Tier 1: Prerequisites						
SSPR1	Construction Activity Pollution Prevention	$0	$0	$0	$0	-
EAPR1	Fundamental Commissioning of the Building Energy Systems	$46,700	$57,000	$0	$0	-
EAPR2	Minimum Energy Performance	$0	$0	$0	$0	-
EAPR3	Fundamental Refrigerant Management	$0	$0	$0	$0	-
MRPR1	Storage & Collection of Recyclables	$0	$119,200	$14,800	$182,700	-
EQPR1	Minimum IAQ Performance	$0	$0	$0	$0	-
EQPR2	Environmental Tobacco Smoke (ETS) Control	$0	$0	$0	$0	-
	Total, Prerequisites:	**$46,700**	**$176,200**	**$14,800**	**$182,700**	-
Tier 2: Mandate or Standard Practice						
EA1(1)	Optimize Energy Performance (First Two Points; See Note 1. Below)	$0	$0	$0	$0	2
EQ7.1	Thermal Comfort, Design	$0	$0	$0	$0	1
ID2	LEED® Accredited Professional	$0	$0	$0	$0	1
WE1.1	Water Efficient Landscaping, Reduce by 50%	$0	$0	$0	$0	1
WE1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	$0	$0	$0	$0	1
	Total, Mandate or Standard Practice:	**$0**	**$0**	**$0**	**$0**	**6**
Tier 3: High Feasibility						
SS4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	$0	$2,600	$0	$0	1
SS4.4	Alternative Transportation, Parking Capacity	$0	$0	$0	$0	1
SS7.1	Heat Island Effect, Non-Roof	$0	$0	$0	$0	1
ID1.3	Innovation in Design: SS7.1-100% Hardscape meets requirements	$0	$0	$0	$0	1
EQ4.1	Low-Emitting Materials, Adhesives & Sealants	$0	$4,100	$0	$0	1
EQ4.2	Low-Emitting Materials, Paints & Coatings	$0	$54,700	$0	$0	1
EQ4.3	Low-Emitting Materials, Carpet Systems	$0	$37,100	$0	$0	1
SS7.2	Heat Island Effect, Roof	$58,300	$71,300	$22,000	$36,500	1
ID1.4	Innovation in Design: SS7.2-SRI 78 for 100% of roof surface	$0	$0	$0	$0	1
SS8	Light Pollution Reduction	$0	$33,700	$0	$0	1
EA5	Measurement & Verification	$7,800	$20,700	$9,600	$38,900	1
EQ1	Outdoor Air Delivery Monitoring	$7,800	$9,300	$1,800	$3,100	1
EQ3.1	Construction IAQ Management Plan, During Construction	$800	$3,900	$0	$0	1
EQ5	Indoor Chemical & Pollutant Source Control	$3,400	$28,500	$3,100	$6,500	1
EQ6.1	Controllability of Systems, Lighting	$0	$25,900	$0	$0	1
EQ7.2	Thermal Comfort, Verification	$0	$0	$1,000	$2,000	1
	Total, High Feasibility:	**$78,100**	**$291,800**	**$37,500**	**$87,000**	**16**
Tier 4: Moderate Feasibility						
SS5.2	Site Development, Maximize Open Space	$0	$0	$0	$0	1
ID1.2	Innovation in Design: SS5.2-Provide 2x Bldg Footprint as open space	$0	$0	$0	$0	1
SS5.1	Site Development, Protect of Restore Habitat	$27,000	$35,000	$0	$0	1
EA3	Enhanced Commissioning	$43,300	$58,300	$0	$0	1
EA4	Enhanced Refrigerant Management	$13,000	$51,800	$14,500	$19,400	1
EQ2	Increased Ventilation	$5,200	$13,000	$37,100	$123,600	1
EQ3.2	Construction IAQ Management Plan, Before Occupancy	$2,600	$7,800	$0	$0	1
EQ4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	$0	$414,500	$0	$0	1
MR4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	$0	$72,300	$0	$0	1
	Total, Moderate Feasibility:	**$91,100**	**$652,700**	**$51,600**	**$143,000**	**9**

		Capital Cost Impact		LCC Impact		
		Low	High	Low	High	Pts
Tier 5: Low Feasibility						
EQ6.2	Controllability of Systems, Thermal Comfort	-	-	-	-	1
SS1	Site Selection	-	-	-	-	1
SS2	Development Density & Community Connectivity	-	-	-	-	1
SS3	Brownfield Redevelopment	-	-	-	-	1
SS4.1	Alternative Transportation, Public Transportation Access	-	-	-	-	1
SS6.1	Stormwater Design, Quantity Control	-	-	-	-	1
SS6.2	Stormwater Design, Quality Control	-	-	-	-	1
WE2	Innovative Wastewater Technologies	-	-	-	-	1
WE3.1	Water Use Reduction, 20% Reduction	-	-	-	-	1
WE3.2	Water Use Reduction, 30% Reduction	-	-	-	-	1
EA2	On-Site Renewable Energy	-	-	-	-	3
MR1.1	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof	-	-	-	-	1
MR1.2	Building Reuse, Maintain 100% of Existing Walls, Floors & Roof	-	-	-	-	1
MR1.3	Building Reuse, Maintain 50% of Interior Non-Structural Elements	-	-	-	-	1
MR2.1	Construction Waste Management, Divert 50% from Disposal	-	-	-	-	1
MR2.2	Construction Waste Management, Divert 75% from Disposal	-	-	-	-	1
MR3.1	Materials Reuse, 5%	-	-	-	-	1
MR3.2	Materials Reuse,10%	-	-	-	-	1
MR4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)	-	-	-	-	1
MR5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally	-	-	-	-	1
MR5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally	-	-	-	-	1
MR6	Rapidly Renewable Materials	-	-	-	-	1
MR7	Certified Wood	-	-	-	-	1
EQ8.1	Daylight & Views, Daylight 75% of Spaces	-	-	-	-	1
EQ8.2	Daylight & Views, Views for 90% of Spaces	-	-	-	-	1
ID1.1	Innovation in Design: SS5.1-Restore 75% of Site	-	-	-	-	1
	Total, Low-Feasibility:					
Tier 6: Non-Construction						
SS4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles	-	-	-	-	1
EA6	Green Power	-	-	-	-	1
	Total, Non-Construction:	$0	$0	$0	$0	**0**

Notes

1. The Energy Policy Act of 2005 will promulgate energy practices within IHS, to exceed ASHRAE 90.1 by 30%. This would earn six points for this LEED credit. For the purposes of this study however, only the first two credits are considered "standard practice."

Summary of First Four Tiers (as a % of total Construction Cost)	Cap. Cost Range		% of Tot.	Points
Prerequisites	$46,700	$176,200	0.1 to 0.2	0
Mandate or Standard Practice	$0	$0	0.0 to 0.0	6
High Feasibility	$78,100	$291,800	0.1 to 0.3	16
Moderate Feasibility	$91,100	$652,700	0.1 to 0.7	9
Total	**$215,900**	**$1,120,700**	**0.2 to 1.2**	**31**

Total, Barrow Construction Budget: $93,282,888

Table 1: Credit Categorization Matrix for Barrow Replacement Hospital

The preceding table (Table 1) contains a summary of credits, categorized in a hierarchy according to feasibility (Prerequisites, Mandate or Standard Practice, High Feasibility, Moderate Feasibility, Low Feasibility, and Non-Construction.)

This table contains several columns of data, explained as follows:

Capital Cost Impact

This data includes a range of anticipated cost impacts, which would be born during the initial construction phase. These costs represent additional costs beyond the costs associated with conventional construction practices currently used by IHS.

Life Cycle Cost Impacts

These numbers represent anticipated costs and savings realized over a 20-year life cycle, attributable to each credit shown in the matrix. Although life cycle costs are assumed under a different budgetary allocation, it is important to identify how a Basic Certification would impact the facility in the long-term as well as in initial construction costs.

Points

For each credit shown in the matrix, the number of points available for each credit is shown in this column.

Discussion of Table 1

Table 1 is similar to Table 2-2 from the Evaluation Study. However, some notable exceptions exist. Because Table 2-2 is intended to be a basis for other facilities, several credits were classified as "Situational." In Table 1 of this report however, every credit was given a clear designation. This eliminated tier 6 from Table 2-2. Because many credits were designated as "Low Feasibility," it isn't expedient to populate the cost factor columns with data. Hence, the focus of this table is the first four tiers.

Several credits were re-categorized in the Barrow case. These are listed below under two classifications: 1) increased feasibility, and 2) reduced feasibility.

Increased Feasibility

- SS7.1 Heat island Effect, Non-Roof Because of the unique site conditions in the Arctic, parking and driving areas are not typically paved. The alternative is gravel, which is a high-albedo surface, thereby eliminating any heat island effects from non-roof areas. This

credit is therefore assumed to be automatic, without additional expense.

- ID1.3 Innovation in Design: SS7.1 – 100% Hardscape meets requirements For reasons identical to SS7.1, this credit is achieved automatically.

Reduced Feasibility

- EQ2 Increased Ventilation Providing additional ventilation in an arctic environment required significant additional system requirements. This is because the outside air is extremely cold and dry most of the year. In fact, outside air must be humidified in Arctic conditions, in order to provide a suitable indoor air environment. Due to these additional requirements, this credit was reduced in feasibility.
- EQ3.2 Construction IAQ Management Plan, Before Occupancy For the same reasons as EQ2, this credit would require burdensome additional provisions, thereby rendering this credit to be less feasible than in the Sisseton (lower 48) case.
- SS6.1 Stormwater Design, Quantity Control The Arctic has a very short thaw season. This changes the conditions for Stormwater significantly. Compliance with this credit would require special nuances, not heretofore addressed in the literature available from the US Green Building Council. For the purposes of this study, this credit was reduced to the "Low Feasibility" category.
- EA2 Onsite Renewable Energy In the Sisseton study, it was determined that photovoltaic technology could be utilized to earn points for this credit. In Barrow however, solar radiation is never intense enough to produce significant energy. The only available onsite renewable energy would be from wind, and this is highly unlikely to be considered in an area where fossil fuels are readily available.
- MR5.1 Regional Materials, 10% Extracted, Processed & Manufactured Regionally Because Barrow is so far from any industrial centers, this credit is virtually impossible to achieve.
- EA1 Optimize Energy Performance (Points 3-7 of 10) In the Sisseton case, additional points were easily earned for energy efficiency, due to the available Ground Source Heat Pump (GSHP) technology, with an accompanying study to validate energy savings claims. In Barrow, environmental conditions preclude the GSHP option; furthermore, no computer simulations are available to investigate potential energy savings with modifications to the design (e.g. reduced glazing, improved insulation systems, energy recovery systems, etc.) To keep this analysis conservative, only the first two points (out of a possible 10) were considered to be feasible.

Due to the elimination of the "Situational" category, these credits were reassigned according to their feasibility in the Arctic. Of these 12 credits, 3 were assigned to "Moderate" feasibility, and 9 were assigned to "Low" feasibility. The credits assigned to "Moderate" include:

- SS5.2 Site Development, Maximize Open Space The plot of land purchased for the Barrow hospital is significantly larger than the currently proposed development footprint. This presents an opportunity to achieve this credit.
- ID1.2 Innovation in Design: SS5.2 – Provide 2x Bldg Footprint as Open Space This innovation in design credit is moderately feasible, due to the reasons stated above, under SS5.2.
- SS5.1 Site Development, Protect or Restore Habitat The significant area not being developed offers the prospect of earning this credit as well. The main constraint would be that tundra cannot be restored. Hence, the open space would need to be completely undisturbed during development (i.e. no staging areas in open space.)

The remaining credits from the "Situational" category presented unique challenges in the Arctic, and were hence assigned to the "Low Feasibility" category.

Tabulation of Results

Using the data from Table 1, the credits are systematically chosen for a Basic LEED certification for Barrow. Results are shown separately for capital costs as well as life cycle costs. Because the Sisseton evaluation was used as a basis for this study, a side-by-side comparison is made, both for capital costs as well as life cycle costs. This data is contained in the following two tables (Table 2 and Table 3.)

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

IHS Evaluation Project - Barrow

B	S			Points Possible	Points Earned B	Points Earned S	Capital Cost Impacts: Basic - Barrow Low	Basic - Barrow High	Basic - Sisseton Low	Basic - Sisseton High
0	0		**Sustainable Sites**	14 Points	6	5	$58,300	$107,600	$22,500	$125,200
✓	✓	Prereq 1	**Construction Activity Pollution Prevention**	Required			$0	$0	$0	$0
		Credit 1	**Site Selection**	1						
		Credit 2	**Development Density & Community Connectivity**	1						
		Credit 3	**Brownfield Redevelopment**	1						
		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1						
✓	✓	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	1	1	$0	$2,600	$0	$1,200
		Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1						
✓	✓	Credit 4.4	**Alternative Transportation**, Parking Capacity	1	1	1	$0	$0	$0	$0
		Credit 5.1	**Site Development,** Protect of Restore Habitat	1						
✓		Credit 5.2	**Site Development,** Maximize Open Space	1	1		$0	$0		
	✓	Credit 6.1	**Stormwater Design,** Quantity Control	1		1			$0	$83,500
		Credit 6.2	**Stormwater Design,** Quality Control	1						
✓		Credit 7.1	**Heat Island Effect,** Non-Roof	1	1		$0	$0		
✓	✓	Credit 7.2	**Heat Island Effect,** Roof	1	1	1	$58,300	$71,300	$22,500	$27,500
✓	✓	Credit 8	**Light Pollution Reduction**	1	1	1	$0	$33,700	$0	$13,000
0	0		**Water Efficiency**	5 Points	2	2	$0	$0	$7,900	$58,100
✓	✓	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	1	1	$0	$0	$7,900	$13,100
✓	✓	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	1	1	$0	$0	$0	$45,000
		Credit 2	**Innovative Wastewater Technologies**	1						
		Credit 3.1	**Water Use Reduction**, 20% Reduction	1						
		Credit 3.2	**Water Use Reduction**, 30% Reduction	1						
0	0		**Energy & Atmosphere**	17 Points	5	9	$110,800	$187,800	$87,700	$152,500
✓	✓	Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required			$46,700	$57,000	$18,000	$22,000
✓	✓	Prereq 2	**Minimum Energy Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 3	**Fundamental Refrigerant Management**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Optimize Energy Performance**	1 to 10	2	7	$0	$0	$50,000	$100,000
		Credit 2	**On-Site Renewable Energy**	1 to 3						
✓	✓	Credit 3	**Enhanced Commissioning**	1	1	1	$43,300	$58,300	$16,700	$22,500
✓		Credit 4	**Enhanced Refrigerant Management**	1	1		$13,000	$51,800		
✓	✓	Credit 5	**Measurement & Verification**	1	1	1	$7,800	$20,700	$3,000	$8,000
		Credit 6	**Green Power**	1						
0	0		**Materials & Resources**	13 Points	0	0	$0	$119,200	$0	$46,000
✓	✓	Prereq 1	**Storage & Collection of Recyclables**	Required			$0	$119,200	$0	$46,000
		Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1						
		Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1						
		Credit 1.3	**Building Reuse**, Maintain 50% 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 3.1	**Materials Reuse**, 5%	1						
		Credit 3.2	**Materials Reuse**,10%	1						
		Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1						
		Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1						
		Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regi	1						
		Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regi	1						
		Credit 6	**Rapidly Renewable Materials**	1						
		Credit 7	**Certified Wood**	1						

B	S									
0	0		**Indoor Environmental Quality**	15 Points	9	11	$12,000	$163,500	$7,600	$71,100
✓	✓	Prereq 1	**Minimum IAQ Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Outdoor Air Delivery Monitoring**	1	1	1	$7,800	$9,300	$3,000	$3,600
	✓	Credit 2	**Increased Ventilation**	1		1			$2,000	$5,000
✓	✓	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1	1	1	$800	$3,900	$300	$1,500
	✓	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1		1			$1,000	$3,000
✓	✓	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1	1	1	$0	$4,100	$0	$1,600
✓	✓	Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1	1	1	$0	$54,700	$0	$21,100
✓	✓	Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1	1	1	$0	$37,100	$0	$14,300
		Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1						
✓	✓	Credit 5	**Indoor Chemical & Pollutant Source Control**	1	1	1	$3,400	$28,500	$1,300	$11,000
✓	✓	Credit 6.1	**Controllability of Systems**, Lighting	1	1	1	$0	$25,900	$0	$10,000
		Credit 6.2	**Controllability of Systems**, Thermal Comfort	1						
✓	✓	Credit 7.1	**Thermal Comfort**, Design	1	1	1	$0	$0	$0	$0
✓	✓	Credit 7.2	**Thermal Comfort**, Verification	1	1	1	$0	$0	$0	$0
		Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1						
		Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1						
0	0		**Innovation & Design Process**	5 Points	4	2	$0	$0	$0	$0
		Credit 1.1	**Innovation in Design**: SS5.1-Restore 75% of Site	1						
✓		Credit 1.2	**Innovation in Design**: SS5.2-Provide 2x Bldg Footprint as open space	1	1		$0	$0		
✓		Credit 1.3	**Innovation in Design**: SS7.1-100% Hardscape meets requirements	1	1		$0	$0		
✓	✓	Credit 1.4	**Innovation in Design**: SS7.2-SRI 78 for 100% of roof surface	1	1	1	$0	$0	$0	$0
✓	✓	Credit 2	**LEED® Accredited Professional**	1	1	1	$0	$0	$0	$0
C	S									
0	0		**Project Totals** (pre-certification estimates)	69 Points	26	29	$181,100	$578,100	$125,700	$452,900
				+ Administrative Costs:			$116,640	$142,560	$45,000	$55,000
				TOTAL:			$297,740	$720,660	$170,700	$507,900

Color Key

- Data fields pertaining to the Barrow case
- Indicates credits chosen for Barrow, which fall under the "Moderate Fesibility" category
- Data fields pertaining to the Sisseton case
- Indicates credits chosen for Sisseton, which fall under the "Moderate Fesibility" category

Table 2: LEED Credit Selection Matrix, Including Capital Cost Impacts

LEED-NC

LEED-NC Version 2.2 Registered Project Checklist

IHS Evaluation Project - Barrow

B	S			Points Possible	Points Earned B	Points Earned S	Life Cycle Cost Impacts: Basic - Barrow Low	Basic - Barrow High	Basic - Sisseton Low	Basic - Sisseton High
0	0	**Sustainable Sites**		14 Points	6	5	$22,000	$36,500	-$9,200	$44,400
✓	✓	Prereq 1	**Construction Activity Pollution Prevention**	Required			$0	$0	$0	$0
		Credit 1	**Site Selection**	1						
		Credit 2	**Development Density & Community Connectivity**	1						
		Credit 3	**Brownfield Redevelopment**	1						
		Credit 4.1	**Alternative Transportation**, Public Transportation Access	1						
✓	✓	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1	1	1	$0	$0	$0	$0
		Credit 4.3	**Alternative Transportation**, Low-Emitting and Fuel-Efficient Vehicles	1						
✓	✓	Credit 4.4	**Alternative Transportation**, Parking Capacity	1	1	1	$0	$0	$0	$0
		Credit 5.1	**Site Development,** Protect of Restore Habitat	1						
✓		Credit 5.2	**Site Development,** Maximize Open Space	1	1		$0	$0		
	✓	Credit 6.1	**Stormwater Design,** Quantity Control	1		1			$0	$49,900
		Credit 6.2	**Stormwater Design,** Quality Control	1						
✓		Credit 7.1	**Heat Island Effect,** Non-Roof	1	1		$0	$0		
✓	✓	Credit 7.2	**Heat Island Effect,** Roof	1	1	1	$22,000	$36,500	-$9,200	-$5,500
✓	✓	Credit 8	**Light Pollution Reduction**	1	1	1	$0	$0	$0	$0
0	0	**Water Efficiency**		5 Points	2	2	$0	$0	-$12,700	$69,200
✓	✓	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1	1	1	$0	$0	$9,200	$21,000
✓	✓	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1	1	1	$0	$0	-$21,900	$48,200
		Credit 2	**Innovative Wastewater Technologies**	1						
		Credit 3.1	**Water Use Reduction**, 20% Reduction	1						
		Credit 3.2	**Water Use Reduction**, 30% Reduction	1						
0	0	**Energy & Atmosphere**		17 Points	5	9	$24,100	$58,300	-$134,300	-$87,000
✓	✓	Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required			$0	$0	$0	$0
✓	✓	Prereq 2	**Minimum Energy Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 3	**Fundamental Refrigerant Management**	Required			$0	$0	$0	$0
✓	✓	Credit 1	**Optimize Energy Performance**	1 to 10	2	7	$0	$0	-$138,000	-$102,000
		Credit 2	**On-Site Renewable Energy**	1 to 3						
✓	✓	Credit 3	**Enhanced Commissioning**	1	1	1	$0	$0	$0	$0
✓		Credit 4	**Enhanced Refrigerant Management**	1	1		$14,500	$19,400		
✓	✓	Credit 5	**Measurement & Verification**	1	1	1	$9,600	$38,900	$3,700	$15,000
		Credit 6	**Green Power**	1						
0	0	**Materials & Resources**		13 Points	0	0	$14,800	$182,700	$5,700	$70,500
✓	✓	Prereq 1	**Storage & Collection of Recyclables**	Required			$14,800	$182,700	$5,700	$70,500
		Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1						
		Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1						
		Credit 1.3	**Building Reuse**, Maintain 50% 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 3.1	**Materials Reuse**, 5%	1						
		Credit 3.2	**Materials Reuse**,10%	1						
		Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	1						
		Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ pre-consumer)	1						
		Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regi	1						
		Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regi	1						
		Credit 6	**Rapidly Renewable Materials**	1						
		Credit 7	**Certified Wood**	1						

B	S								
0	0	**Indoor Environmental Quality**	15 Points	9	11	$5,900	$11,600	$17,200	$53,400
✓	✓	Prereq 1 **Minimum IAQ Performance**	Required			$0	$0	$0	$0
✓	✓	Prereq 2 **Environmental Tobacco Smoke** (ETS) **Control**	Required			$0	$0	$0	$0
✓	✓	Credit 1 **Outdoor Air Delivery Monitoring**	1	1	1	$1,800	$3,100	$700	$1,200
	✓	Credit 2 **Increased Ventilation**	1		1			$14,300	$47,700
✓	✓	Credit 3.1 **Construction IAQ Management Plan**, During Construction	1	1	1	$0	$0	$0	$0
	✓	Credit 3.2 **Construction IAQ Management Plan**, Before Occupancy	1		1			$0	$0
✓	✓	Credit 4.1 **Low-Emitting Materials**, Adhesives & Sealants	1	1	1	$0	$0	$0	$0
✓	✓	Credit 4.2 **Low-Emitting Materials**, Paints & Coatings	1	1	1	$0	$0	$0	$0
✓	✓	Credit 4.3 **Low-Emitting Materials**, Carpet Systems	1	1	1	$0	$0	$0	$0
		Credit 4.4 **Low-Emitting Materials**, Composite Wood & Agrifiber Products	1						
✓	✓	Credit 5 **Indoor Chemical & Pollutant Source Control**	1	1	1	$3,100	$6,500	$1,200	$2,500
✓	✓	Credit 6.1 **Controllability of Systems**, Lighting	1	1	1	$0	$0	$0	$0
		Credit 6.2 **Controllability of Systems**, Thermal Comfort	1						
✓	✓	Credit 7.1 **Thermal Comfort**, Design	1	1	1	$0	$0	$0	$0
✓	✓	Credit 7.2 **Thermal Comfort**, Verification	1	1	1	$1,000	$2,000	$1,000	$2,000
		Credit 8.1 **Daylight & Views**, Daylight 75% of Spaces	1						
		Credit 8.2 **Daylight & Views**, Views for 90% of Spaces	1						
0	0	**Innovation & Design Process**	5 Points	4	2	$0	$0	$0	$0
		Credit 1.1 **Innovation in Design**: SS5.1-Restore 75% of Site	1						
✓		Credit 1.2 **Innovation in Design**: SS5.2-Provide 2x Bldg Footprint as open space	1	1		$0	$0		
✓		Credit 1.3 **Innovation in Design**: SS7.1-100% Hardscape meets requirements	1	1		$0	$0		
✓	✓	Credit 1.4 **Innovation in Design**: SS7.2-SRI 78 for 100% of roof surface	1	1	1	$0	$0	$0	$0
✓	✓	Credit 2 **LEED® Accredited Professional**	1	1	1	$0	$0	$0	$0
C	S								
0	0	**Project Totals** (pre-certification estimates)	69 Points	26	29	$66,800	$289,100	-$133,300	$150,500
		Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points				0.1%	0.3%	-0.8%	0.9%

Color Key

- Data fields pertaining to the Barrow case
- Indicates credits chosen for Barrow, which fall under the "Moderate Fesibility" category
- Data fields pertaining to the Sisseton case
- Indicates credits chosen for Sisseton, which fall under the "Moderate Fesibility" category

Table 3: LEED Credit Selection Matrix, Including Life Cycle Cost Impacts

Discussion of Tables 2 and 3

A quick look at the preceding two tables shows an anticipated capital cost impact of approximately $298,000 to $721,000 to implement a Basic LEED Certification at Barrow. This compares to $171,000 to $508,000 for the same certification level at Sisseton. As a percentage of the construction budget however, the comparison is particularly worth noting. Whereas Sisseton shows a cost impact of between 1% and 3%, in Barrow, the percentage impact is estimated between 0.3% and 0.8%. The most prominent reason for this significant difference is the large difference in construction budgets between the two facilities (the Barrow construction budget is roughly 5 ½ times the construction budget at Sisseton. The unique climate factors and logistical limitations are the reasons for such a large difference. In the case of LEED credits however, much of the points are earned through relatively minor changes. As a percentage of the overall construction cost, these are significantly less.

Table 3 shows an anticipated 20-yr life cycle cost impact in Barrow to be between $67,000 and $289,000. Sisseton on the other hand, shows a range from -$133,000 (life cycle savings) to $151,000. The impact as a percentage of the initial construction budget is between 0.1% and 0.3% for Barrow, -0.8% to 0.9% for Sisseton. Once again, the significant ratio between initial construction costs is the main cause for this difference. Perhaps the most important difference to note here is the potential life cycle cost savings, which are not realized in Barrow. The primary cause for this is the decision not to pursue additional energy savings in Barrow, whereas the Sisseton evaluation took considerable energy savings as a basis for LEED pursuit.

One difference between the two studies, is that a 3-point buffer was figured into the Sisseton evaluation. For Barrow however, this strategy was not used. More available data could be used with Sisseton, because the design is complete, and construction is already underway. With Barrow however, pursuing additional cost impact factors would have required additional design information, which is not yet available. The only other way to develop the necessary cost figures would be to make wide assumptions without sufficient basis for the purposes of this study. A subjective look at credits not pursued in this study would show several credits, which would likely be feasible. For example, more points would likely be achieved under EA1 – Optimize Energy Performance. Due to the Energy Policy Act of 2005 (EPACT), the IHS will be more aggressively pursuing energy savings as a matter of policy. Strict compliance with the EPACT will earn more points than the two assumed under this study.

Conclusion

The intent of this study was to utilize the data obtained from the LEED Cost Evaluation Study, completed in June 2006 and apply it to Barrow in order to examine the feasibility of pursuing LEED Certification in an arctic environment. This has been accomplished by re-evaluating each credit, while considering factors unique to this environment. Costs were recalculated, using the Sisseton cost factors as a basis, and applying additional factors, based on location factors, increased facility space, etc.

These factors were developed for both capital as well as life cycle costs, and the resulting premiums are summarized in tables 2 and 3. A side by side comparison with the Sisseton template shows where primary differences exist. A comparison of construction cost impacts is shown in the following table.

	Certified - Barrow		Certified - Sisseton	
	Low	High	Low	High
LEED Construction Cost Impacts				
Cost Impact	$297,740	$720,660	$170,700	$507,900
$/GSF	$2.98	$7.21	$2.01	$5.98
% Change	0.3%	0.8%	1.0%	3.0%

Table 4: Comparison of Construction Cost Impacts – LEED Basic Certification

Life cycle costs are summarized in Table 5, showing overall costs (20-year life cycle,) and normalized costs (expressed in $/GSF.)

	Certified - Barrow		Certifed - Sisseton	
	Low	High	Low	High
LEED Life Cycle Cost Impacts*				
20-yr Life Cycle Cost Impacts	$ 66,800	$ 289,100	$ (133,300)	$ 150,500
$/GSF	$ 0.67	$ 2.89	$ (1.57)	$ 1.77

* Numbers shown in parenthesis indicate a negative life cycle cost impact, i.e. net savings as opposed to costs.

Table 5: Comparison of Life Cycle Cost Impacts – LEED Basic Certification

Because life cycle costs are expressed in present value dollars, these values are added to establish *aggregate life cycle costs*. These are summarized in Table 6.

	Certified - Barrow		Certified - Sisseton	
	Low	High	Low	High
Aggregate Life Cycle Cost Impacts				
$/GSF	$3.65	$10.10	$0.44	$7.76
% Change	0.4%	1.1%	0.2%	3.9%

Table 6: Aggregate Life Cycle Cost Impacts – LEED Basic Certification

This summary shows that total costs (including life cycle costs over 20 years) are relatively minor, especially when expressed as a percentage of the total construction budget.

Through evaluating each credit, some key discoveries were made, relating to the feasibility of credits considered under the Sisseton case, compared to the Barrow case, where some credits realized an increased feasibility and others, a reduced feasibility. This highlights site specific factors, which are quite different in the Arctic, when compared to the lower 48 states.

The results of this study indicate that the pursuit of LEED Certification in an arctic environment may actually be less significant than in more conventional settings. The relatively high cost of arctic construction may result in LEED costs that are a much smaller percentage of the whole. Therefore, for budgetary purposes it is reasonable to assimilate anticipated LEED costs within existing project budgets.

Appendix

Contents:

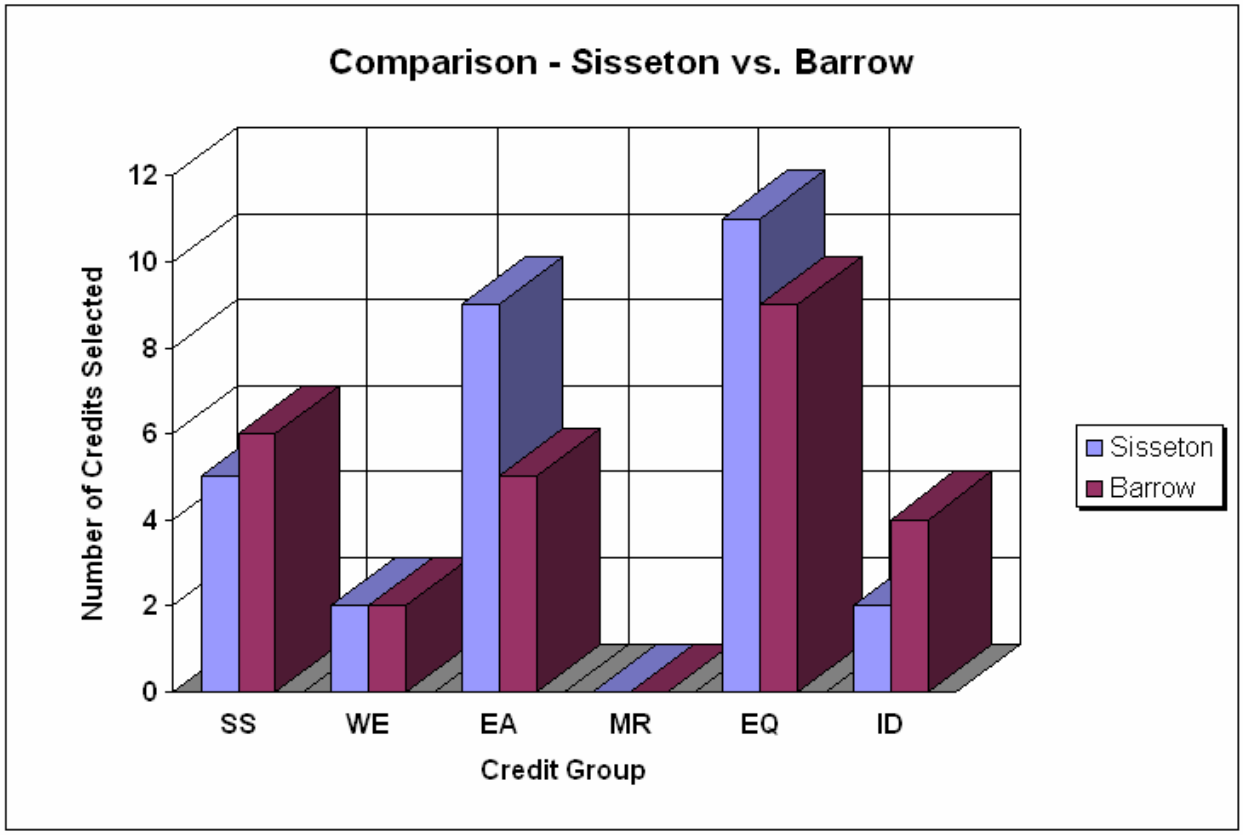
Appendix 1: Comparison of Credit Selections

Appendix 2: Capital Cost Estimates – Individual Credits

Appendix 3: Life Cycle Cost Estimates – Individual Credits

Credit Comparison - Barrow vs. Sisseton

	Sisseton		Barrow	
	Credits	Cost	Credits	Cost
SS	5	$125,200	6	$107,600
WE	2	$58,100	2	$0
EA	9	$152,500	5	$187,800
MR	0	$46,000	0	$119,200
EQ	11	$71,100	9	$163,500
ID	2	$0	4	$0
Total	29	$452,900	26	$578,100



Capital Cost Estimates - Individual Credits

		Cost Calculation Factors						Cost Impact	
Credit	Title	1.	2.	3.	4.	5.	6.	Low	High
SS4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	$0	$1,200	1	2.16	N/A	N/A	$0	$2,600
SS4.4	**Alternative Transportation**, Parking Capacity	$0	$0	1	1	N/A	N/A	$0	$0
SS5.1	**Site Development,** Protect of Restore Habitat	$0	$21,000	1	1	$27,000	$35,000	$27,000	$35,000
SS5.2	**Site Development,** Maximize Open Space	$0	$0	1.2	2.16	N/A	N/A	$0	$0
SS7.1	**Heat Island Effect,** Non-Roof	$120,000	$143,400	1.2	2.16	$0	$0	$0	$0
SS7.2	**Heat Island Effect,** Roof	$22,500	$27,500	1.2	2.16	N/A	N/A	$58,300	$71,300
SS8	**Light Pollution Reduction**	$0	$13,000	1.2	2.16	N/A	N/A	$0	$33,700
WE1.1	**Water Efficient Landscaping**, Reduce by 50%	$7,900	$13,100	1.2	2.16	$0	$0	$0	$0
WE1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	$0	$45,000	1.2	2.16	$0	$0	$0	$0
EAPR1	**Fundamental Commissioning of the Building Energy Systems**	$18,000	$22,000	1.2	2.16	N/A	N/A	$46,700	$57,000
EA1	**Optimize Energy Performance (First Two Points)**	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EA3	**Enhanced Commissioning**	$16,700	$22,500	1.2	2.16	N/A	N/A	$43,300	$58,300
EA4	**Enhanced Refrigerant Management**	$5,000	$20,000	1.2	2.16	N/A	N/A	$13,000	$51,800
EA5	**Measurement & Verification**	$3,000	$8,000	1.2	2.16	N/A	N/A	$7,800	$20,700
MRPR1	**Storage & Collection of Recyclables**	$0	$46,000	1.2	2.16	N/A	N/A	$0	$119,200
MR4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	$0	$27,900	1.2	2.16	N/A	N/A	$0	$72,300
EQ1	**Outdoor Air Delivery Monitoring**	$3,000	$3,600	1.2	2.16	N/A	N/A	$7,800	$9,300
EQ2	**Increased Ventilation**	$2,000	$5,000	1.2	2.16	N/A	N/A	$5,200	$13,000
EQ3.1	**Construction IAQ Management Plan**, During Construction	$300	$1,500	1.2	2.16	N/A	N/A	$800	$3,900
EQ3.2	**Construction IAQ Management Plan**, Before Occupancy	$1,000	$3,000	1.2	2.16	N/A	N/A	$2,600	$7,800
EQ4.1	**Low-Emitting Materials**, Adhesives & Sealants	$0	$1,600	1.2	2.16	N/A	N/A	$0	$4,100
EQ4.2	**Low-Emitting Materials**, Paints & Coatings	$0	$21,100	1.2	2.16	N/A	N/A	$0	$54,700
EQ4.3	**Low-Emitting Materials**, Carpet Systems	$0	$14,300	1.2	2.16	N/A	N/A	$0	$37,100
EQ4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	$0	$159,900	1.2	2.16	N/A	N/A	$0	$414,500
EQ5	**Indoor Chemical & Pollutant Source Control**	$1,300	$11,000	1.2	2.16	N/A	N/A	$3,400	$28,500
EQ6.1	**Controllability of Systems**, Lighting	$0	$10,000	1.2	2.16	N/A	N/A	$0	$25,900
EQ7.1	**Thermal Comfort**, Design	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ7.2	**Thermal Comfort**, Verification	$0	$0	1.2	2.16	N/A	N/A	$0	$0
ID1.2	**Innovation in Design**: SS5.2-Provide 2x Bldg Footprint as open space	$0	$0			N/A	N/A	$0	$0
ID1.3	**Innovation in Design**: SS7.1-100% Hardscape meets requirements	$240,000	$286,800	1.2	2.16	$0	$0	$0	$0
ID1.4	**Innovation in Design**: SS7.2-SRI 78 for 100% of roof surface	$0	$0	1.2	2.16	N/A	N/A	$0	$0
ID2	**LEED® Accredited Professional**	$0	$0	1	1	N/A	N/A	$0	$0

Notes on Cost Factors

1. Capital Cost Premium from Sisseton Study, "Low" Cost Scenario
2. Capital Cost Premium from Sisseton Study, "High" Cost Scenario
3. Scaling Factor for Difference in GSM and Staffing of Barrow Facility vs. Sisseton (1.2 where applicable, 1.0 otherwise)
4. Ratio of Location Factors between Barrow and Sisseton (2.03 ÷ 0.942 = 2.16 Where Applicable.) Where location factors do not apply, 1.0 is used
5. Alternative "Low" Cost Scenario, which supercedes Sisseton Cost Basis
6. Alternative "High" Cost Scenario, which supercedes Sisseton Cost Basis

Life Cycle Cost Estimates - Individual Credits

		Cost Calculation Factors						Cost Impact	
Credit	Title	1.	2.	3.	4.	5.	6.	Low	High
SS4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	$0	$0	1	2.16	N/A	N/A	$0	$0
SS4.4	**Alternative Transportation**, Parking Capacity	$0	$0	1	1	N/A	N/A	$0	$0
SS5.1	**Site Development,** Protect of Restore Habitat	$0	$0	1	1	N/A	N/A	$0	$0
SS5.2	**Site Development,** Maximize Open Space	$0	$0	1.2	2.16	N/A	N/A	$0	$0
SS7.1	**Heat Island Effect,** Non-Roof	$0	$0	1.2	2.16	N/A	N/A	$0	$0
SS7.2	**Heat Island Effect,** Roof	$8,500	$14,100	1.2	2.16	N/A	N/A	$22,000	$36,500
SS8	**Light Pollution Reduction**	$0	$0	1.2	2.16	N/A	N/A	$0	$0
WE1.1	**Water Efficient Landscaping**, Reduce by 50%	$0	$0	1.2	2.16	N/A	N/A	$0	$0
WE1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EAPR1	**Fundamental Commissioning of the Building Energy Systems**	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EA1	**Optimize Energy Performance (First Two Points)**	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EA3	**Enhanced Commissioning**	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EA4	**Enhanced Refrigerant Management**	$5,600	$7,500	1.2	2.16	N/A	N/A	$14,500	$19,400
EA5	**Measurement & Verification**	$3,700	$15,000	1.2	2.16	N/A	N/A	$9,600	$38,900
MRPR1	**Storage & Collection of Recyclables**	$5,700	$70,500	1.2	2.16	N/A	N/A	$14,800	$182,700
MR4.1	**Recycled Content**, 10% (post-consumer + ½ pre-consumer)	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ1	**Outdoor Air Delivery Monitoring**	$700	$1,200	1.2	2.16	N/A	N/A	$1,800	$3,100
EQ2	**Increased Ventilation**	$14,300	$47,700	1.2	2.16	N/A	N/A	$37,100	$123,600
EQ3.1	**Construction IAQ Management Plan**, During Construction	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ3.2	**Construction IAQ Management Plan**, Before Occupancy	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ4.1	**Low-Emitting Materials**, Adhesives & Sealants	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ4.2	**Low-Emitting Materials**, Paints & Coatings	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ4.3	**Low-Emitting Materials**, Carpet Systems	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ5	**Indoor Chemical & Pollutant Source Control**	$1,200	$2,500	1.2	2.16	N/A	N/A	$3,100	$6,500
EQ6.1	**Controllability of Systems**, Lighting	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ7.1	**Thermal Comfort**, Design	$0	$0	1.2	2.16	N/A	N/A	$0	$0
EQ7.2	**Thermal Comfort**, Verification	$1,000	$2,000	1.2	2.16	$1,000	$2,000	$1,000	$2,000
ID1.2	**Innovation in Design**: SS5.2-Provide 2x Bldg Footprint as open space	$0	$0			N/A	N/A	$0	$0
ID1.3	**Innovation in Design**: SS7.1-100% Hardscape meets requirements	$0	$0	1.2	2.16	N/A	N/A	$0	$0
ID1.4	**Innovation in Design**: SS7.2-SRI 78 for 100% of roof surface	$0	$0	1.2	2.16	N/A	N/A	$0	$0
ID2	**LEED® Accredited Professional**	$0	$0	1	1	N/A	N/A	$0	$0

Notes on Cost Factors

1. Capital Cost Premium from Sisseton Study, "Low" Cost Scenario
2. Capital Cost Premium from Sisseton Study, "High" Cost Scenario
3. Scaling Factor for Difference in GSM and Staffing of Barrow Facility vs. Sisseton (1.2 where applicable, 1.0 otherwise)
4. Ratio of Location Factors between Barrow and Sisseton (2.03 ÷ 0.942 = 2.16 Where Applicable.) Where location factors do not apply, 1.0 is used
5. Alternative "Low" Cost Scenario, which supercedes Sisseton Cost Basis
6. Alternative "High" Cost Scenario, which supercedes Sisseton Cost Basis